JOURNAL SMPTE

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Progress Committee Report

By CHARLES R. DAILY, *Committee Chairman*

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1953 will be remembered as a year of revolutionary change and progress in motion pictures and television. The advent of Cinerama and 3-D in the latter part of 1952 stirred the motion-picture industry into intense activity. The showings of Cinerama continued throughout the year and more theaters were added for its exhibition. 3-D pictures enjoyed considerable popularity for a time and thousands of theaters were equipped for showing them. With the improved methods now under development, 3-D may well establish itself in the future as a stable part of the entertainment industry. Stereophonic sound and sound placement spread from the Cinerama to 3-D and other showings. Theaters by the thousands took on the "New Look" by installing larger screens. Hundreds of CinemaScope installations were completed here and many abroad, introducing much wider screens, a new screen shape, anamorphic lens and single-film, 4-track stereophonic sound. Drive-in theaters increased in popularity and number, and the size of their new screens has been markedly increased due to higher reflective screen materials. The

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introduction of larger screens necessitated more lighting which led to improved lamphouses, carbons, lenses and screen materials with a higher light gain.

The need for larger negative images in the camera to offset the loss of definition from the larger screens was being met with a number of new camera designs. Cinerama and CinemaScope used larger negatives; and Paramount introduced the VistaVision process, using a special horizontal double-frame camera which makes possible a marked improvement in picture quality on standard release prints. *White Christmas* was the first production made by this new method. Todd-AO is testing a 65mm negative, and other larger-negative processes are under development.

The television industry has been equally active. Many new stations have been opened in the UHF band. The FCC approved the NTSC color standards proposal and excellent demonstrations of color TV have been held, including the transcontinental broadcast of color programs. The recording on magnetic tape of both black-and-white and color pictures was demonstrated — a truly revolutionary development. Kinescoping techniques were markedly improved and film projection equipments underwent a considerable change. Pay-as-you-see television and community distribution systems for television were inaugurated by Telemeter on a commercial basis in California and other areas.

To Make a Fuller Report

The material which follows has been obtained from numerous sources, and while it gives an overall picture of progress during 1953, it is far from being a complete record of what was accomplished during this eventful year. In order to make the report covering new developments for 1954 more complete, it is suggested that any company or individual send, during the year, a brief note describing the development in question to Society headquarters in New York, labelling it to be directed to the Progress Committee. If this procedure were followed by interested individuals all over the world, the next Progress Report could be much more informative and complete.

Stereoscopic Productions

General. Following the boxoffice success of *Bwana Devil* released late in 1952, many pictures were produced in 3-D and many new equipments and screens developed. In the United States, the productions used two 35mm cameras, two negatives, two prints and two projectors running in synchronism. Polarizing filters were used in front of the projectors and the audience used individual viewers. Most productions used pairs of regular 35mm motion-picture cameras in special mountings and the Norling[1] specially built camera was also used. Variable interaxial spacing and angle of convergence controls were provided.

Paramount[2] and Universal also used two-mirror systems, but arranged them so that both the interaxial spacing and convergence angle could be varied. Columbia[3] and Universal used two Mitchell cameras side by side, with one inverted in order to get the lenses close enough together. However, the most generally used mounting in all studios had one of the cameras straight ahead, with the other mounted at right angles; Ramsdell[4] patented an arrangement with the two cameras at right angles shooting through a semitransparent mirror which could be rotated slightly to change the convergence angle.

Warner Brothers developed an ingenious control system which incorporated a dial indication of the actual distance to the convergence plane for any lens and control setting. This considerably reduced alignment time on the set. The Research Council[5] proposed a

simplified dial arrangement which served the same purpose, and this was adopted by several of the studios.

Based on recently discovered principles of stereoscopic vision, the Motion Picture Research Council[6] proposed an improved system for setting interaxial spacing and convergence angle to give the desired results when pictures were projected on theater-size screens. Most of the distortion and eyestrain due to these two factors were overcome. These recommendations were incorporated in a special calculator developed by the Research Council[7] and have been adopted by most of the major studios and other producers both in this country and abroad.

Many nondepolarizing screens were developed and installed. The generally higher brightness gain of such metallic screens helped overcome the severe light loss occasioned by the polarizing filters and the increased screen gain also aided in the improving of conventional pictures presented on wide screens.[8–11] Reel lengths were increased to 5000 ft so that only one intermission would be required. The accurate synchronization of the projectors lead to special interlocking equipment, both mechanical and electrical. Provisions for cooling and keeping the polarizing filters aligned in the booth were developed. The two light sources had to be carefully balanced to give the best results. Proper projection procedures were prepared by the Research Council[9] and distributed throughout the industry.

Synchronization problems were the hardest to solve and successful future 3-D showings will no doubt use single-film projection. Several single-film 3-D systems were developed. The Nord Corp. projection attachment uses a pair of prints side by side on a standard width of film. Projection through angled mirrors rotates the images, passes them through suitable filters and superimposes them on the screen.

The Moropticon system differs principally in the manner in which the images are rotated. With the somewhat reduced film areas and the loss in the mirrors, light levels at the screen are below those obtained with dual projectors.

Vectograph[12] is a promising possibility for superimposing a stereoscopic pair of pictures on a single film. Such film requires no filters at the projector and the effective light levels should be somewhat higher with a single projector than can now be obtained with two projectors. No extra booth equipment is required except a nondepolarizing screen and individual viewers.

Polarizing sheet filters were provided by Polaroid, Polalite, Polacoat and others.[13] More comfortable viewing will be obtained with the newer-type wire stiffening, and clip-on type of polarizing glasses.

One feature picture was produced in England in 3-D, *The Million Dollar Diamond* which was photographed with Raymond Spottiswoode's Spacemaster camera which claims very accurate positioning of the photographic pairs. The exhibition of 3-D pictures was quite limited in Germany and, as far as is known, no 3-D feature entertainment productions were produced in Germany. However, considerable progress was made in the use of 3-D techniques for research and scientific work, particularly 3-D X-ray pictures.

3-D Polarizing Materials. Viewers and filters of many types were produced. Polyvinyl alcohol-iodine types were distributed by the Polaroid Corp.,[13] and the Polalite Corp. in the United States, and by Mitsubishi in Japan. The Polacoat Co. used oriented dichroic dyes on a plastic base.

Vectograph. Progress on the Vectograph single-film process was reported by Polaroid Corp.[12]

Alignment Techniques for Theater Projectors. For the projection of 3-D pictures using two mechanical or electrical interlocked projection machines, the Polar-

oid Corp. developed two types of 3-D synchronization monitors.[14] The electronic Model 21 monitor shows on an easily read meter which film, if either, is lagging and by how much. Errors as small as $\frac{1}{10}$ frame or as large as 5 frames are automatically indicated. The simpler stroboscopic Model E monitor was also developed and over a thousand are in use. The Polaroid Corp. also developed a 3-D synchronization control switch[14] to eliminate synchronization error without interrupting the show. They also introduced dichroic polarizing filters tinted red and green for use in the booth to give a gross indication of lead or lag with one projector in respect to the other.

Several single-film systems were developed using two images on the same piece of film. None of these single-film systems has yet received commercial acceptance in the professional 35mm entertainment field. The SMPTE and Motion Picture Research Council issued alignment test films. The MPRC also designed a new calculator to simplify camera alignment in photography in 3-D pictures.

16mm Stereoscopic Projection

Various equipments are now available for synchronizing two 16mm projectors for 3-D work. Bolex, Elgeet and Nord have developed camera attachments for single-film photography in 3-D.

A constant-speed device for synchronization of two 16mm projectors was built by Bauer,[15] Stuttgart, and used for special showings of *House of Wax* on 16mm in Holland.

Wide-Screen Installations

During 1953 thousands of theaters installed much larger screens. In many cases these filled the entire proscenium arch and pictures were then shown at the various aspect ratios suggested by the studios supplying the film. Audience reaction to the larger screens was good and at year's end it seemed quite certain that the larger screens had become established as a fixed part of theater construction.

In order to increase the amount of light reflected to the audience, and also with the stimulus of 3-D, many of the new screens used an aluminized finish. Some had the aluminum surface sprayed on. Others had the aluminizing material built into the screen material itself, some had a semilenticular surface and others had a complete lenticular embossed surface which improved both the lateral and vertical distribution of light to the audience. The larger screens required that more light be provided from the booth, and toward this end new lamphouses and carbons were made available to markedly increase the light output. Also introduced to reduce heat at the film were air-cooling systems and interference-type heat filters which reflected unwanted heat before the light beam reached the film. Better and higher-speed lenses were introduced by a number of manufacturers. Following the precedent set by Cinerama, stereophonic and peripheral sound equipments were installed in many houses.

Drive-Ins

Approximately 4000 drive-in theaters were in service at the end of the year and many more were under construction or on the drawing board. Following the lead of the large-screen installations in outdoor theaters, and coupled with the improvement in reflective screen materials, many of the newer drive-ins are being built with much larger screens than heretofore. As an example, the 970-car LaMirada Drive-In at Downey, Calif., opened in November 1953 with a screen 65 ft by 85 ft. The entire screen is tilted toward the audience 8° from the vertical.

The screen is of an entirely new design using vertical flutes cast into a plaster surface. The basic design of the curvature of the flutes was worked out by the Motion Picture Research Council. Af-

ter sealing, the plaster surface is painted with the proper type of aluminum paint which has a light gain of 2½ and a proper vertical distribution lobe. The flutes give good horizontal distribution. The plaster face is applied to 1-in. thick lightweight aggregate-type concrete 4- by 8-ft panels, steel-reinforced. It is understood that experiments are now under way with extruded aluminum sheets with the vertical flutes embossed into the material. Some new drive-in screens are curved and many are being planned with much larger dimensions, generally with an aspect ratio of approximately 2 to 1.

Cinerama

Cinerama, the first of the wide-screen systems, demonstrated clearly the audience appeal of peripheral vision effects. In this respect the process has gone well beyond other developments which followed. Supplementing the new screen approach with stereophonic sound yields a medium which continues to maintain unusual audience appeal. By the end of 1953 nine theaters throughout the country were showing the Cinerama film, and more installations were in progress.

The development of Cinerama established the concept that real peripheral effects require true wide-angle photography projected on a deeply curved screen of sufficient size to approach encompassment of the audience, within practical limitations. The screen must be illuminated at normally experienced levels, or better, maintaining good light distribution and picture resolution over the entire screen area. Installed in a theater of appropriate design, a high degree of intimacy and feeling "a part of the picture" is achieved.

Three separate picture films are employed throughout the process and are so projected as to present a continuous scene. There is necessity for very accurate control of every step in the process from camera to screen to assure accurate registration of the three separate images. The three light sources must be evenly matched and provide uniform illumination over the screen segments to avoid objectionable variations near the joint area of adjacent pictures.

Although performance quality in respect to these requirements was acceptable in the initial Cinerama presentation, it is recognized that increased picture stability, improved light distributions and joint area blending is desirable in future productions. A second production now in process is expected to reflect considerable progress in these matters.

Stereophonic Sound

The R-8 3-track magnetic sound reproducer was developed by Westrex for separate sound-film reproduction which was used to provide stereophonic sound with 3-D and other 35mm theater release prints during the year (Fig. 1). Westrex also developed the penthouse modification of the RA-1035 magnetic recording system for 3 or 4 tracks. The magnetic heads are the plug-in type and are furnished for 3-track ASA position, 4-track CinemaScope master or 4-track CinemaScope release position. This adds facilities for RA-1467-A magnetic recorder now widely used (Fig. 2). Westrex developed the RA-1517-B triple-track, double-flywheel, stereomagnetic recorder. This unit has low flutter content, and high volume range and signal-to-noise ratio.

The RCA PG-300 Stereophonic Sound System consisted of the MI-9030 separate triple-track magnetic sound reproducer with 5500-ft magazines, the unit being selsyn motor interlocked with the picture projector. Triple-channel, 70-w amplification was used with three sets of stage speakers. Kinevox, Inc., produced theater reproducing sound systems for the Natural Sound Corp. of Hollywood. Altec developed magnetic stereophonic reproducers using the triple-track separate magnetic film for

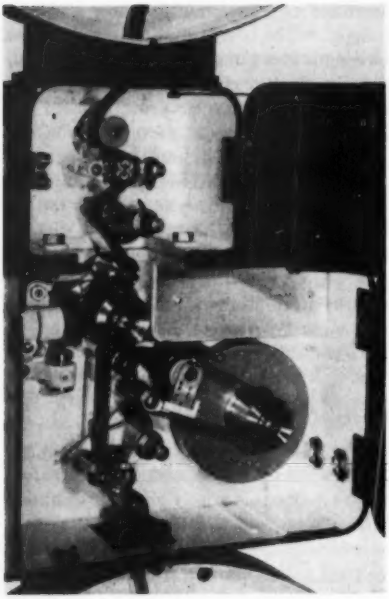

Fig. 1. The Westrex R-8 three-track, double-flywheel magnetic reproducer for separate sound film reproduction, shown with dummy projector.

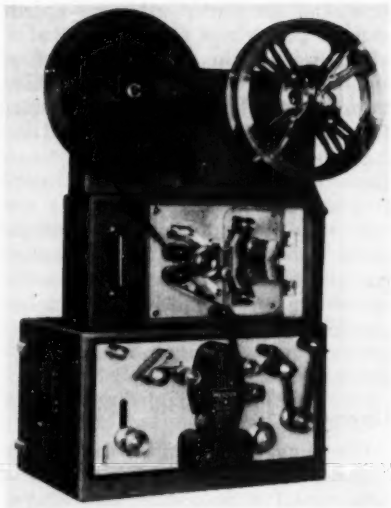

Fig. 2. The Westrex Penthouse stereo-magnetic recorder.

3-D pictures beginning with Warner Bros. *House of Wax*. Siemens-Klangfilm and Philips developed complete systems of amplifier and loudspeaker equipments for stereophonic sound reproduction.

Sound-Placement Systems

The M-G-M-Fine sound-replacement system, using a standard optical release print, has been demonstrated. This system uses several subsonic frequencies recorded in the sound-track areas to control the gain of the amplifiers of each loudspeaker channel. Complete control of the placement of sound from the stage or auditorium horns is thereby achieved

The Dorsett Laboratories of Norman, Okla., have devised an inexpensive system of controlled loudspeaker switching wherein the sound from a standard optical release print from the normal center-stage loudspeaker is moved to the left or right, or to both, and/or to the peripheral auditorium loudspeakers. The switching cues are in the form of a binary code marked into both sprocket-hole areas. When optically scanned, the code signals operate switching relays. This system of sound placement is used in several theaters in Oklahoma and Texas. Standard, single-track optical release prints are cued for use with this system by the Dorsett representatives.

CinemaScope

The following description was submitted by Lorin D. Grignon of Twentieth Century-Fox:

CinemaScope, a totally new means of presenting motion pictures, developed by Twentieth Century-Fox Film Corp., was first shown to the public during 1953. It is a coordinated combination of known techniques, improved or modified to

better suit the process and delivered to the theater on a single composite film of new design. Uniquely, CinemaScope was conceived and engineered, standards were established, the manufacturers were organized and the system was promoted in less than ten months from the time of preliminary tests to the public release of *The Robe*, September 16, 1953. To the audience it means only a picture of width approaching peripheral vision with stereophonic sound, but several engineering advancements were required.

The wide picture aspect ratio of 2.55 : 1 is realized on 35mm film by the use of anamorphic lens systems of a horizontal factor of 2 for the taking lens on the camera and the projector attachment. These lens systems are based on the work of Prof. Henri Chretien of France in the late 20's and early 30's,[16,17] modernized and improved for CinemaScope by the Bausch & Lomb[18] 2-in. to 6-in. focal lengths, and when applied correctly to these lenses doubles the horizontal angle of view without affecting the vertical direction. The film image appears in correct vertical proportions but is squeezed in the horizontal direction. The projector attachments are available in two sizes to fit the two standardized diameters of projector lenses currently available. The projector anamorphics exactly restore the horizontal structure of the image to natural proportions. During the year, Bausch & Lomb delivered over 200 camera and over 4000 projector attachments. Additionally, Bell & Howell, in the United States, British Optical & Precision Engineers, Ltd., in England, Société Technique d'Optique et de Photographie in France; I. D. Möller-Optische Werke, GmbH, and Carl Zeiss in Germany; Officien Galileo de Milano, S.P.A., in Italy; Bausch & Lomb A.B., in Sweden; and Nippon Kogaku K.K., in Japan, started manufacture.

CinemaScope provides for full 3-channel stereophonic sound using essentially the methods described in the *Journal*.[19–22] Three independent soundtracks are used on the release film for theater reproduction by three amplifiers and loudspeaker systems. The stereophonic system is augmented by signals, from a fourth soundtrack, which are reproduced from loudspeakers mounted on the walls of the theater, to surround the audience with sound when appropriate to the scene. When the full capabilities of the system are used, sound enhances the wide picture so as to provide a practical approach to audience participation. Also recorded on the fourth track, simultaneously with the signal to be reproduced, is a constant-level signal of 12 kc which operates sensing and switching circuits in the theater to activate the fourth channel; when there is an absence of 12 kc, the surround reproduction channel is muted to assure that no background and random noises from the surround loudspeakers detract from the reproduction from the screen loudspeakers.

The new positive release film, of standard 35mm width, offers a balanced design providing more usable film area for picture and sound by means of a reduction in perforation dimensions. The result of extensive tests and consideration of all factors, technical and economic, was a perforation 0.073 by 0.078 in. spaced 1.127 in., center-to-center.[27] The hole is a Dubray-Howell perforation (ASA-PH22.1-1953)[23] of reduced width. New sprockets having teeth of 0.040-in. face width spaced axially 1.125 in., center-to-center, on a pitch diameter of 0.953 in. (dimension B, ASA-PH22.36–1954)[24] are recommended for use with CinemaScope film. The new sprockets operate equally well with the new or any presently used positive film and, in either situation, film life is increased.

The last several years have brought the use of magnetic materials for sound

recording and reproduction into very wide use in all communication fields, other than motion-picture release, by virtue of numerous basic superiorities. CinemaScope presented an opportunity to introduce magnetic soundtracks advantageously into the theater field; accordingly, magnetic materials are striped upon the picture print, after processing, to create the composite sound and picture release print. Although of lesser width than the conventional optical release tracks, superior signal-to-noise ratio is obtained and the reproduced frequency characteristics can be extended to 8 kc without significant loss. The three principal tracks are of 0.063-in. width; the fourth track is of 0.029-in. nominal width.[27] Magnetic coating machinery has been developed by Reeves Soundcraft, Bell & Howell, Eastman Kodak, and Pyral of France. Minnesota Mining is presently developing a means to laminate solid magnetic tape materials onto 35mm film.

The use of multiple magnetic tracks demanded a new reproducer design.[25–27] It has been found universally convenient and advantageous to design and manufacture a wholly new unit to be mounted on the projector between the projector mechanism and the upper magazine. The problem of conversion parts for the many types of soundheads is thereby obviated and the performance, and use, of optical or magnetic scanning systems is not compromised in any way. All of the new reproducer attachments are film driven, have good flutter performance, satisfactory freedom from sprocket-hole modulation and are designed for adaptation to a large variety of projectors. One was used both as a recorder and reproducer to make and project the first composite film demonstration in CinemaScope in August 1953. Approximately 1200 theaters were fully equipped by year's end. Manufacturers in this country in full-scale production of theater equipments are: International Projector Corp., RCA Victor Div., Westrex Corp., Altec Lansing Corp., Ampex Electric Corp., Magnasync Manufacturing Co., the Ballantyne Co., Motiograph Co. and Century Projector Co.

In the foreign field, sound equipment was manufactured by G.B.-Kalee Ltd., RCA Photophone, Ltd., Sound Equipment, Ltd., Western Electric Co., Ltd., in England; Brockliss-Simplex, S.A., Westrex Corp., Etablissements Charlin, S.A., Compagnie Radio-Cinema, in France; Zeiss-Ikon A.G., Siemens-Halske Aktiengesellschaft, in Germany; Cinemeccanica S.P.A., Compagnia Generale di Costruzioni Cinematografiche e Radioelettroniche, Ing. Angelo Fedi S.A., Microtecnicca S.P.A., Officine Pio Pion, Officine Prevost, in Italy; Aga, in Sweden; Produit Perfectone S.A., in Switzerland; and N. V. Philips, in The Netherlands.

The large picture used with CinemaScope would suffer from lack of sufficient brightness unless the available projector light could be made more effective. Consequently, as a part of the CinemaScope "package," Twentieth Century-Fox engineered, developed and put into production a lenticular screen material available in two basic patterns. The screen surface is composed of small precisely embossed optical elements to reflect perpendicularly incident light rays within a useful vertical included angle of 60° and a horizontal angle of 100°. Within these limits the reflection factor is relatively uniform providing good viewing from all seats of the average theater. By this device, the apparent screen brightness, with a given incident intensity, is increased by two times. One pattern is used for essentially head-on projection and the other, a tilted element pattern, is useful for high-angle projection. In all installations it has been found desirable to hang the screen on a curve whose radius is that of the projector throw. The screen carries the trade name of Miracle Mirror. This screen material,

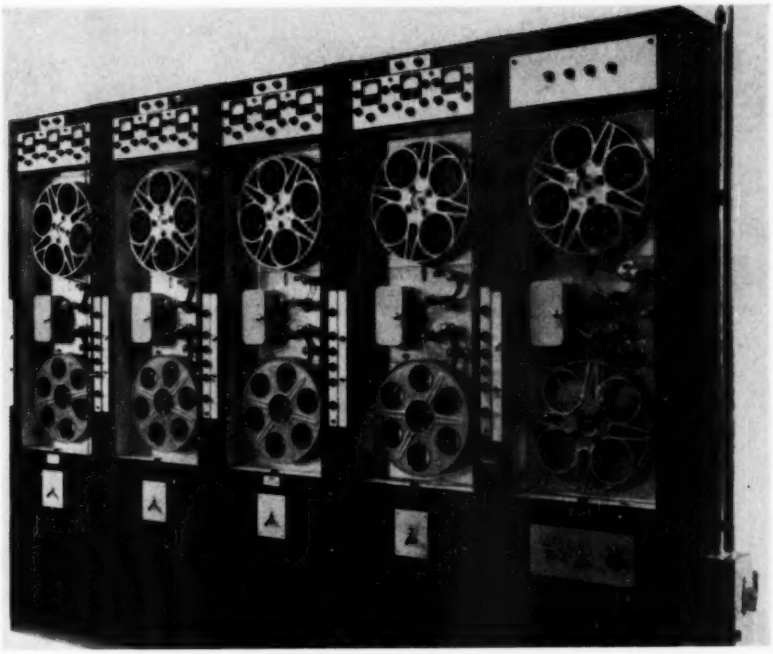

Fig. 3. The Westrex CinemaScope Sound Printer

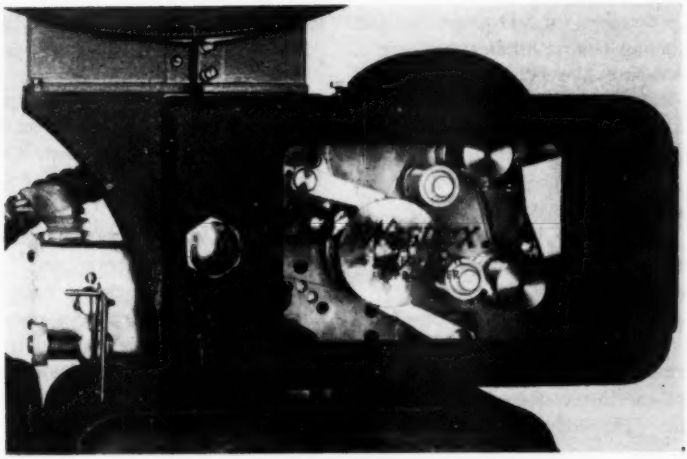

Fig. 4. The Westrex R-9 stereophonic four-track magnetic reproducer. Operating side closed.

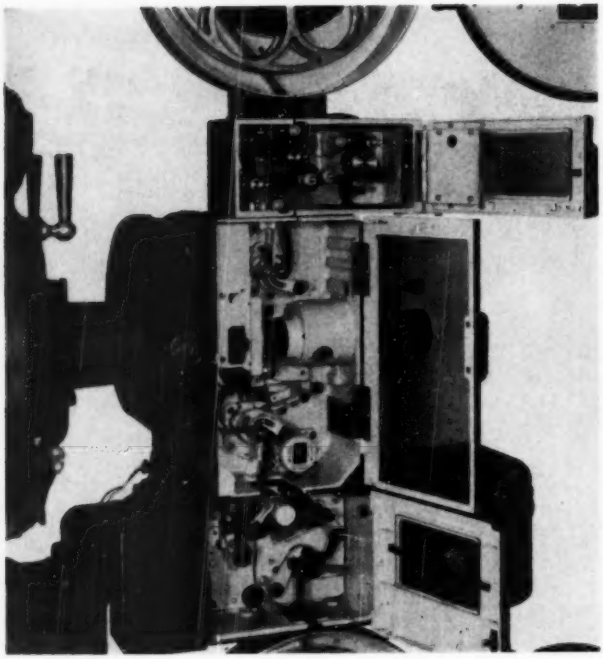

Fig. 5. The RCA CinemaScope sound system.

because of metallic reflection characteristics, is excellent for 3-D projection and hence is universal in application.

Screens are also being made abroad by A. R. Brackell, in Australia; British Optical & Precision Engineers, Ltd., in England; Michel Avenard, in France; Siemens-Halske Aktiengesellschaft, in Germany; Cinemeccanica S.P.A., in Italy; Jose Jover S.A. and Industria Electronica S.A., in Spain; and A. S. Nils Nessim, in Sweden.

Between September 5 and December 31, 1953, approximately 5,000,000 ft of release film had been produced and put into use in the domestic and foreign markets. This footage was represented by four feature productions, a number of short subjects and an industrial film. Using the same methods, other studios and independent producers were making features for general release in 1954.

CinemaScope Equipment

Westrex developed a release "printer" for multiple-track recording on striped theater prints for Twentieth Century-Fox Film and M-G-M. This printer, an adaptation of the Westrex RA-1506 recorder[28] reproduces four magnetic soundtracks from a master negative film and records four tracks on each of five composite release prints in one operation. An RA-1505 cabinet-type rerecorder and five RA-1506 recorders are used (Fig. 3). Westrex developed the R-9 penthouse reproducer (Fig. 4) for theater projectors.[25] It uses two impedance drums, tight film loop, and the well-known Davis-drive and flutter sup-

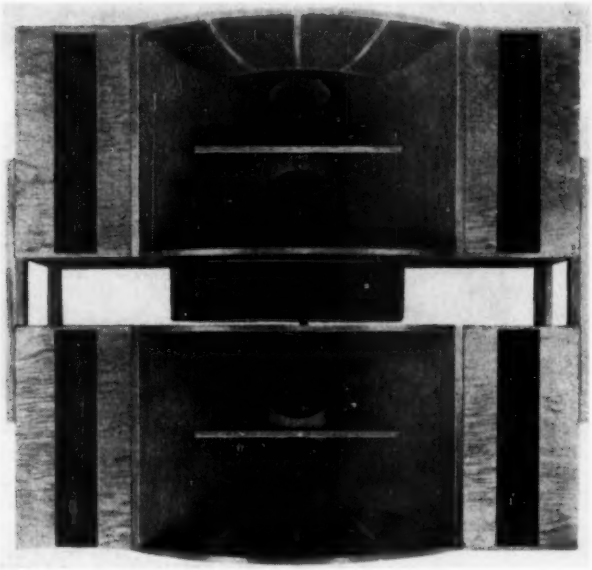

Fig. 6. RCA Stereoscope speakers.

pressor. An idler-roller permits adjustment to various lengths of film paths required for different makes of projectors.

Altec designed and manufactured several hundred penthouse reproducers and complete stage and auditorium surround speaker, amplifier and change-over systems.

RCA developed a complete sound system for CinemaScope (Fig. 5), including a "button-on" 4-track magnetic head cluster, film-driven soundhead, amplifier and suppressor panel.[26] Where booth space permitted, 5500-ft magazines were installed. The RCA Wide-Arc Lamp can operate 10-mm Hitex positive carbons at 135 amp. The new-type "Ubangi" stage speakers (Fig. 6) have excellent fidelity and coverage.

Motiograph introduced the AAA magnetic penthouse reproducer which uses a tight-loop film transport system, a minimum of magnetic material in the assembly, a tilt top to space the upper magazine away from the front wall and a "snubber" roller to reduce or eliminate film damage at the start of a reel.

Magnasync is producing the Magnaphonic PH-1435 penthouse reproducer (Fig. 7) for use with CinemaScope. It is protected against magnetic flux patterns generated by the projector motor and remote "dowser" solenoid. The WC-435 preamplifier group protects the side-wall speakers from the 12-kc control frequency. A master ganged fader for the three stage speakers, power supplies and a series of power amplifiers complete the stereophonic reproduction system.

Ampex developed three series of stereophonic playback equipments for CinemaScope motion pictures: Super systems, with a bank of preamplifiers for each projector and complete electronic change-over; DeLux systems with all protection features of the Super, but with manual change-over; and Master systems with extensive protection fea-

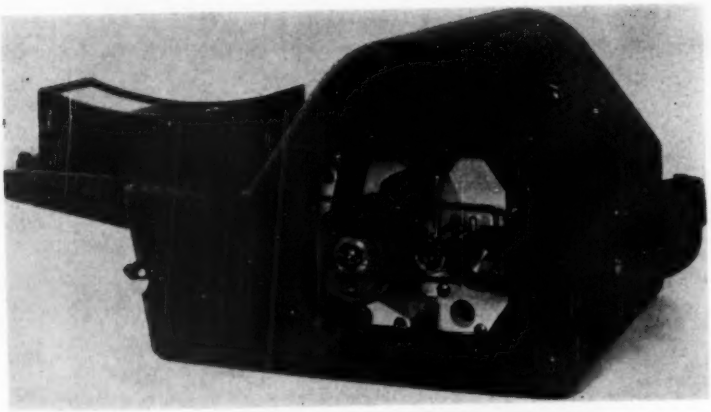

Fig. 7. Magnasync Penthouse Reproducer PH-1435.

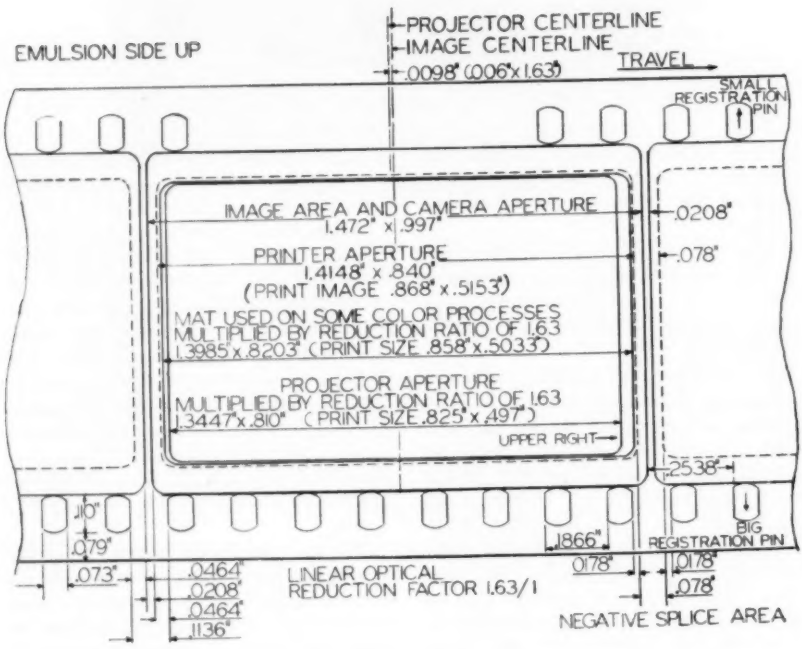

Fig. 8. VistaVision Camera frame dimensions, shown for aspect ratio of 1.66 : 1. Height appropriately reduced for aspect ratio of 1.85 : 1.

tures, but great simplicity, for maximum compactness and economy. A new line of theater loudspeakers was manufactured by Ampex under license from James B. Lansing Sound, Inc. G.B.-Kalee, RCA and Western Electric have produced excellent magnetic recorders and multitrack apparatus in England. In Germany,[29] the Bauer, Philips and Zeiss-Ikon factories have developed all sound and projector accessories for CinemaScope and other anamorphic processes. Installation is proceeding slowly in Germany because of the reported high investment required under present boxoffice conditions.

VistaVision

Paramount introduced the VistaVision process during the latter part of 1953. The most important feature of this new photographic system is the use of a large original negative in the camera, coupled with a substantial optical reduction to obtain standard release prints. Since the grain and resolution of a negative are much poorer than print materials, the use of the large negative produces a marked reduction in grain as seen on the theater screen coupled with a considerable increase in resolution. Release prints will carry a single optical track and can be played on any standard theater equipment, without modification, anywhere in the world. The photography is being composed for best projection at an aspect ratio of 1.85:1 but sufficient latitude has been allowed for projection at standard aspect ratios of 1.33:1 up to 2:1. Higher aspect ratios are not recommended. Figure 8 shows the VistaVision camera frame dimensions for an aspect ratio of 1.66:1.

White Christmas was the first feature production completed in the VistaVision process. Using standard 35mm negative in a special camera, a double-frame area is exposed which has an area $2\frac{1}{2}$ times larger than that used in standard cameras. Standard camera lenses which will cover the double-frame image are used in a special camera,[30] originally known as the Lazy 8, which has the negative travel horizontally through the camera. A negative area 1.472 × 0.997 in. is exposed. This special camera is equipped with a remote-controlled focusing device and a remote-controlled finder. The negative is handled in the standard manner through normal developing machines. An optical printer rotates the image the required 90° and reduces the image to standard release-print size. The release prints use standard positive perforations.

Todd-AO[31]

The wide-angle photographic process developed by Dr. Brian O'Brien for 65-mm film is the basis for the Todd-AO Corp. entrance into the wide-screen field. While not yet publicly released, this system is said to approach Cinerama in spectacular presentation, using, however, a single camera and projector! Ampex produced a series of record and playback mechanisms for the Magna Theatre Corp. to be used with the Todd-AO process. Magnetic record and synchronized playback machines of multichannel construction were built using 35mm sprocketed magnetic film. These were used for a number of private showings in Buffalo and New York.

Magnetic Striping

The four magnetic stripes used on CinemaScope tremendously expanded the use of striped magnetic sound films. Reeves Soundcraft produced a new striping machine (Fig. 9) for Twentieth Century-Fox Film which applies the four magnetic soundtracks to the color release prints at 150 ft/min. The machine uses the familiar method of flowing a suspension of magnetic oxide onto the film from a properly shaped and calibrated orifice.

Reeves Soundcraft have made available prestriped raw stock in a variety of

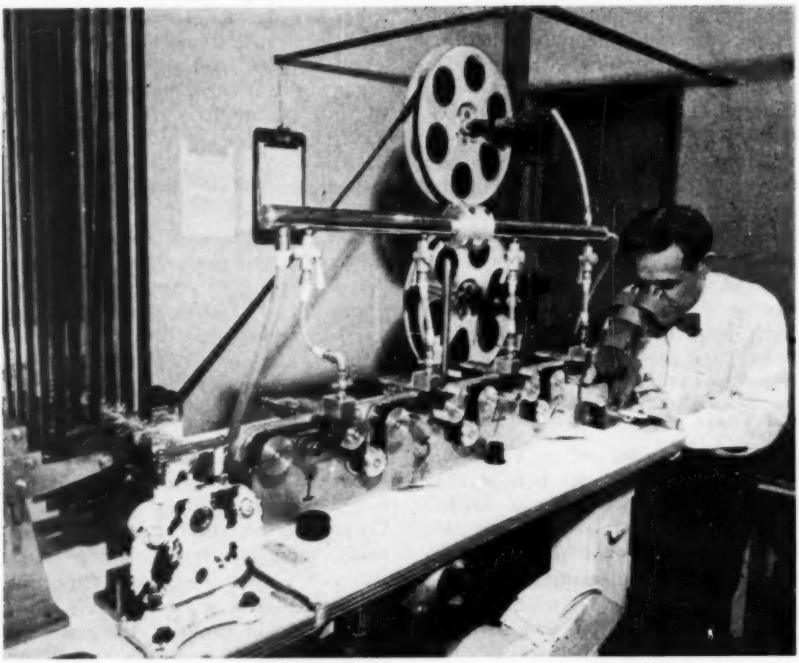

Fig. 9. The Reeves 35mm "Magna-Striper" installed at Fox Laboratories.

combinations, including a 35mm and 16mm sound-recording negative, Panchromatic and certain reversal color films. The sound-recording material is used by Columbia and others to record simultaneously an optical track and a magnetic track on the same film. The optical track is then used in editing and the final mix is made from the magnetic stripe, thus preserving the quality advantage of the magnetic system for the final mix. The prestriped negative materials are expected to prove useful for newsreels and similar uses where time does not permit the striping after editing and for classified work where the film must not be permitted out of the hands of the agency responsible.

The Minnesota Mining process, which transfers a magnetic coating from a temporary tape support to the film, was improved during the year by the addition of a pretreatment process which permits the stripe to adhere on either emulsion or base side of the film, and to film of any age or previous history. Commercial field trials have been run on this process at the Calvin Laboratories, Kansas City, Mo., and at McGeary-Smith Laboratories in Washington, D.C. Tracks of any width between 0.025 in. and 0.125 in. can be striped at 100 ft/min.

The Minnesota Mining Tape #125 is a new full-coated film stock for original recording and editing work. The "high-output" oxide coating increases the output about 10 db and has recording characteristics similar to the #120 "high-output" magnetic tape introduced in 1953.

In the foreign field, Pyral, of Paris, have installed striping equipment in a number of countries to support the use of 16mm magnetic-sound projectors in those countries. Pyral have improved their equipment during the year by the addition of an electromagnetic thickness-measuring device, which enables the operator accurately to control the thickness of the stripe as it is being applied.

In Germany, equipment has been installed for striping of CinemaScope film and striping is being done on 16mm film for television recording and on 8mm film for amateur use.

Optical Developments

The Hanovia Chemical & Mfg. Co. announced the first commercial production of optical-quality fused quartz in the United States. In addition to providing the optical industry with an additional source of fused quartz for use in ultraviolet transmission systems, it is expected that the electronic engineers will make use of this material for ultrasonic delay.[32]

Rudolf Frerichs announced new optical glasses with good transparency in the infrared. These glasses, which are being developed to a production stage by the Servo Corp. of America, have been previously reported in the literature without benefit of production development.[33,34]

An inverted telephoto-type wide-angle lens system capable of coverages up to 160° for use in scoring cameras was developed by the Douglas Aircraft Co. and the Wollensak Optical Co. Two versions of this system have been developed, one for 16mm cameras and one for 35mm cameras. While these lenses are not corrected to the degree required for theater-type motion-picture photography, they are entirely adequate for their intended application.[35] It is reported that a 165° taking lens has also been developed for use with the Todd-AO process, shooting on 65-mm film.

16 mm Stereoscopic. 16 mm stereo photography found increased use in the commercial and amateur fields. Bolex, Nord and Elgeet developed taking and projection lenses. Included in the group of equipment released by Elgeet, for example, were the taking and projection lenses, viewfinder, screen and spectacles. The 13-mm $f/2.8$ lens fits standard 16mm "C" mount cameras, and a pair of $f/1.6$ lenses will fit standard 16mm projectors.

CinemaScope: 35mm. The CinemaScope process, which is described in a separate section, required compressing optics on the cameras and expanding optics on the projectors. Numerous companies produced anamorphic cylindrical lenses, most of which behave like a reversed Galilean telescope in the horizontal meridian, halving the focal length of the objective and doubling the field coverage. In the vertical meridian the cylindrical attachment has no power, hence has no effect upon the focal length.[36,37] Other companies that developed expansion-compression lenses were the Simpson Optical Mfg. Co. through the Vistarama Corp., Goerz American, Shiga Bros. of Japan, Oude Delft Optical Industries in Delft, Holland, and others. The Delrama optical system for anamorphic projection built by Oude Delft uses two mirrors instead of lenses and is reported to correct the "hollow" horizon and "leaning" skyscraper effects noted with cylindrical projection-lens systems. Taylor, Taylor & Hobson are manufacturing prismatic types as well as cylindrical refractive anamorphic projection lenses. A variable expansion-compression anamorphotic-ratio, prism-type optical attachment for taking and projection is under development by the Tushinsky Bros. The Shiga Bros. are reported to have developed an anamorphic camera lens with a pickup angle of 135° when used with a regular 25-mm lens on a 35mm camera.

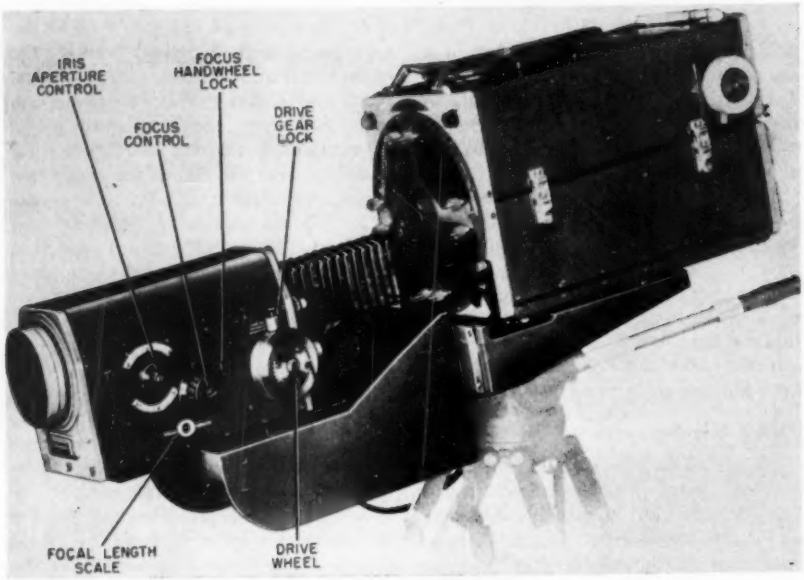

Fig. 10. The GPL-Watson Vari-Focal Lens PA-861.

CinemaScope: 16mm. The rapid acceptance of the 35mm CinemaScope system interested at least two companies, Bell & Howell and Vistarama, to the extent that versions of the larger-frame systems were introduced for the 16mm market. Bell & Howell has a projection lens for the 35mm Fox CinemaScope theater projection[38] as well as a taking and projection unit for the 16mm version. The Vistarama Corp. lenses, manufactured by the Simpson Optical Mfg. Co., are usable for both film sizes.[39]

Zoom Lenses. M-G-M announced and demonstrated the Expansa projection lens which is a variable-focal-length lens designed for theater use. With this lens the picture can be fitted in width and height to meet installation requirements and the focal length can be changed while the film is running to vary the size of the projected picture.

Zoomar Corp. announced the introduction of the Zoomar 16 for the 16mm camera. The lever-operated lens and coupled rangefinder have been designed for a focal range of from 1 to 3 in. at a maximum aperture of $f/2.8$.[40]

Taylor, Taylor & Hobson developed the Varotal zoom lens for use with television cameras, particularly for extreme, long shots of the Coronation.

The GPL-Watson Vari-Focal lens, Model PA-861 (Fig. 10), is a zoom-type camera lens for use in conjunction with television or 35mm motion-picture cameras. Focal ranges of 3 to 15 in. and 6 to 30 in. are available, by a replacement of the rear lens element. The focal-length change can be made continuously in controlled intervals varying from 2 to 30 sec.

Miscellaneous. Kern-Paillard introduced their Kern-Yvar-Filten 12.5-mm $f/2.8$ lens for 8mm cameras. This lens is unusual in mechanical construction in

that four filters mounted on a turret inside the lens mount are an integral part of the unit. The filters included are yellow, red, daylight conversion and skylight.

Cameras

Data on CinemaScope, VistaVision, 3-D, Todd-AO, 16mm professional and cameras for television are described under their representative sections. In addition, Mitchell Camera Corp. developed an improved "follow focus attachment" for professional studio photography. It permits NC, standard and 16mm Mitchell cameras to be used for rapid changes of focus with full control of picture framing and lens focusing even at close critical distances.

The 35mm Arriflex was made available in a blimp and with an improved-type gyro-tripod head. Both the 35mm and 16mm Arriflex cameras are now equipped with optical bench-type attachments (Fig. 11) for the use of long-focal-length lenses. An interesting new micro-stop-motion device for 16mm cameras was announced by Werkstatt fuer Feinmechanik of Berlin.

16mm Projection

A new 16mm projector with a tungsten source is now equipped with a shutter which shifts from three interruptions per frame for operation at silent speed to two interruptions per frame at 24 frames/sec to gain light output. Philips[41] announced a new 16mm projector, Type EL-5000 with a 60° pulldown, increasing the light output from a conventional 50% to 67%.

New Color and Black-and-White Films

Eastman introduced their Type 5248 Color Negative Film, Type 5382 Color Print Film and Type 5245 Color Internegative. These films, together with Type 5216, Panchromatic Separation Film, already available, filled all requirements for color motion-picture production including special effects.[42,43] The

Fig. 11. The 35mm Arriflex camera.

35mm Color Negative incorporated coupler multilayer-type film which is developed to a negative dye image. Some of the couplers are themselves colored and produce color-corrected images. The film is balanced for 3200 K incandescent illumination with ASA exposure index of 25. The Color Print Film is an incorporated coupler multilayer-type film for use on suitably modified continuous contact motion-picture prints, or from color separation negatives on registering prints. The Color Internegative is a 35mm incorporated coupler multilayer-type film containing colored couplers which result in color-corrected images.

Ansco introduced their Type A-44 high-speed tungsten balanced color negative film with an exposure index of 25. Fifteen feature pictures were photographed with this new Ansco film during 1953. Du Pont introduced two new fine-grain 16mm films, the Rapid Reversal Pan Type 930 and High Speed Rapid Reversal Pan Type 931. These films permit rapid processing and have superhardened emulsions which permit the use of elevated processing tem-

peratures. Both of these films can be used as negatives or with reversal processing.

In England, the integral tripack Ferrania Colour, Gevacolor and Eastman Colour films have been much more widely used. The Ilford Company brought out a new black-and-white Type HPS panchromatic negative with a daylight speed of 400 Weston and a tungsten speed of 300 Weston. It has provided small-grain size and appears to be a great advancement in emulsion manufacture.

The papers reported under references 44 through 54 cover many interesting developments in the use of color and black-and-white films.

Color Photographic Systems

Eastman color negative and positive 35mm films were extensively used in processing laboratories during 1953, The following laboratories were handling these films: Ace Laboratories, New York; Alexander Film Laboratories, Colorado Springs; Color Corp. of America, Burbank; Consolidated Film Industries, Hollywood and Fort Lee; Deluxe Laboratories, New York and Hollywood; Lakeside Laboratories, Gary; M-G-M Laboratory, Hollywood; Pathé Laboratories, New York and Hollywood; Technicolor Motion Picture Laboratory, Hollywood; Tri-Art Laboratories, New York; and Warner Brothers Laboratory, Hollywood.

Eastman 16mm color positive film was being used by Pathé Laboratories in New York to make reduction prints from 35mm Eastman color negative. Most laboratories were using subtractive printing methods, although the trend toward additive printing became pronounced.

Ansco color negative and positive films in 35mm were being processed by the following laboratories: Consolidated Film Industries, Fort Lee; Houston Colorfilm Laboratories, Burbank; M-G-M Laboratory, Hollywood. Ansco color film in 16mm positive was being handled at Consolidated Film Industries, Fort Lee. Du Pont 35mm color positive film was being processed by Consolidated Film Industries in Hollywood and Fort Lee.

Technicolor Motion Picture Corporation supplied 35mm and 16mm prints made by the imbibition transfer process from negatives prepared in three-strip, Eastman color, Ansco color, Kodachrome and successive exposure. Color Corp. of America prepared duplitized 35mm and 16mm prints in two- and three-color from bipack negatives and Eastman color negatives.

Film-Handling Equipment

The use of magnetic film for editing purposes increased steadily throughout the year both for theatrical and television use. The average film editor accepts magnetic "dailies" and uses them with a greater freedom of operation than ever before existed on photographic film.

The Westrex Editer film editing machine was introduced to the industry in 1953.[55] It can handle both standard and the new small-hole perforated 35mm films, film strips, motion-picture films, magnetic or photographic sound films (single or multiple), composite release prints, and for the first time makes possible the "projection viewing" of an enlarged image on a wall or screen without extra attachments.

A new editing machine, Type Record, has also been built by Union of Berlin for optical and magnetic soundtracks with built-in differential gears for film displacement and loop changes.

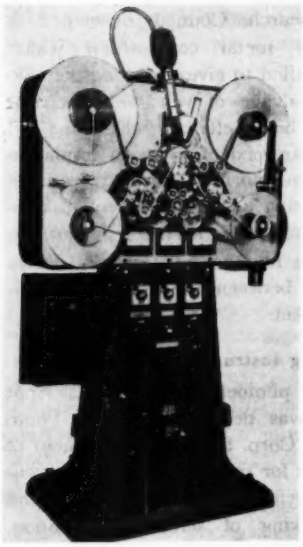

Fig. 12. Arnold & Richter 35mm to 16mm optical reduction printer.

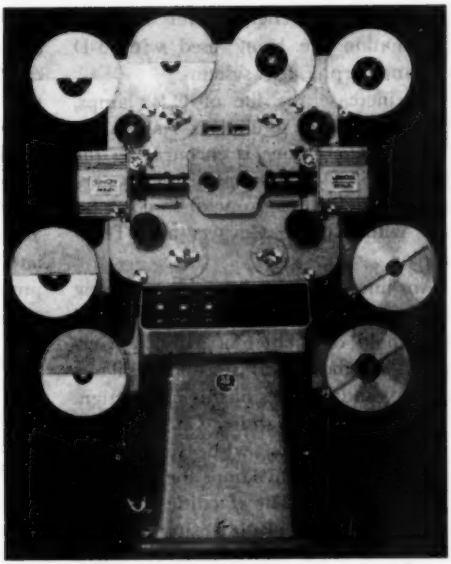

Fig. 13. Union "Optima" 35mm to 16mm reduction printer.

Arnold & Richter of Munich, Germany, have brought out an improved 35mm to 16mm optical reduction printer (Fig. 12).[56] The new "Multicolor 1" registration printer for color separation negatives, operating at 20 frames/sec, has been brought out by Union of Berlin. Union has also made a 35mm to 16mm optical reduction printer called the Optima, which uses an improved registration-pin system (Fig. 13). A new daylight developing machine, Type UEM, with sprocketless rollers, is available from Union, Berlin, while the Type 351-V for color processing has been built in separate sections for installation as space permits. Arnold & Richter[56] have brought out a 16mm reversal film developing machine with automatic temperature and speed controls.

The quality obtained in England in blowing up 16mm original Kodachrome to 35mm for the *Conquest of Everest* is renewing interest in this process for difficult location situations.

Motion-Picture and Television Stage Lighting

With practically all color photography now being made with tungsten light sources, the 10-kw incandescent tungsten lamp has found much wider use. Some 1400 lamp housings for this bulb have been adapted from other incandescent or arc housings. Mole-Richardson introduced the 10-kw Tenner, Type 416 incandescent lamp and a 5-kw flood for tungsten-lit color photography. Newly designed, lighter-weight Junior, Baby and Single and Double Broads, and Skylite flood also came into service. Various new "skypan" types of lighting units have come into use for overall illumination with considerable use being found for the 1-kw silver bowl

reflector lamp. Higher levels of stage illumination are being used with 3-D and anamorphic lens systems.

To increase the life of C.P. lamps, the British Film Producers Association Lighting Committee is encouraging the use of 3250 K lamps. Studies are being made of this proposal in cooperation with Kodak, Gevaert and Technicolor.

An interesting new arc lamp using three carbons at 180 amp was developed by Arnold & Richter of Munich, Germany. A motionless arc and tailflame are basic advantages of this new design.

The Century Lighting Co. has done considerable work with remote-controlled incandescent lamps for television stage lighting. The facilities include remote control of intensity without change of color temperature or distribution pattern, an important feature for the future of the lighting of color television. Remote-controlled pan and tilt and elevation are also incorporated in these units, together with the necessary simplified operator control pedestals.

Set Construction

A number of plastics and allied materials[57,58] found application in set construction and the fabrication of props and statuary. One studio[59,60] is now using Fiberglas-reinforced polyester resins as a replacement for casting with plaster. Weight is reduced and mechanical strength increased which many times justifies the higher cost of the plastic material.

Emulsion paints of the polystyrene and styrene copolymer types are finding use in interior applications, while polyvinyl acetate and polyacrylic coating formulations are finding some use for outdoor applications. For making imitation metallic props, the Motion Picture Research Council developed a cold-spray metal composition which can be buffed to give a striking metallic luster. Salvage of worn-out electrical cables is being effected where the old cable is stripped of its worn insulation and drawn into new extruded neoprene jackets, using a simple vacuum process. The lubricant which is used changes at a later time into an adhesive or friction promoter between cable core and neoprene jacket.

Measuring Instruments

A new photoelectric Brightness Spot Meter[61] was developed by the Photo Research Corp. for the measurement of brightness for small areas. This instrument is useful for both photography and the checking of screen illumination. Agfa brought out a new-type logarithmic-scale exposure meter called the Lucimeter intended for professional use in studios.

High-Speed Photography

There was a marked increase in the field of high-speed photography during 1953. The bibliography in this field is now quite complete: 466 references are included in the new book *High-Speed Photography* by George A. Jones[62]; 581 references were published in the January 1951 issue of the *Journal;* 207 additional references[63] were published in December 1953; and 36 references are included as a part of this report. Short-duration electrical spark methods were described by Chesterman,[64] Fayolle and Naslin,[65] and Schardin.[66] Courtney-Pratt[67] described a method for dissecting a picture into small elements using a plate embossed with many small lenses. This paper lists 99 references.

New commercial-type equipment described during the year includes: a full-frame 35mm Fastax camera with 500-ft

film capacity operating up to 2500 frames/sec[68]; a 70mm camera taking 25 pictures/sec, each $2\frac{1}{4} \times 5$ in., or 50 pictures/sec, each $2\frac{1}{4} \times 2\frac{1}{2}$ in.[69]; a 70mm X-ray motion-picture camera providing 15 frames/sec, each $2\frac{1}{4} \times 2$ in.[70]; a 70mm intermittent-action, pin-registered camera providing up to 450 frames/sec, each $\frac{1}{5} \times 2\frac{1}{2}$ in.[71]; and wide-angle optics used on high-speed motion-picture cameras to provide a field of view up to 160°.[35]

Southard[72] describes three methods used in recording the images of both 4-in. and 80-in. lenses on one roll of film so that a single radar boresight tracking camera can obtain a wide field of view during early stages of a missile's flight and a large missile image during later portions of flight.

Edgerton and Germeshausen[73] report refinement of a previously described[74] magnetooptic shutter which permits reduction of exposure time from 4 μsec to 1 μsec. This shutter has been used extensively at the Ballistic Research Laboratory, Aberdeen Proving Ground in the study of high-velocity shock waves and flame fronts.

Lipton and Saffer[75] describe extensive modifications that have been made in Askania cinetheodolites by Aberdeen Proving Ground and the Naval Gun Factory. The new instruments incorporate improved bearings, data circles and mount components; a camera operating synchronously up to 64 frames/sec as contrasted to the present top rate of 4 frames/sec; 500-ft film capacity and telescopic optical systems of varying focal lengths up to 180 in.

A valuable analysis of glow lamps used for high-speed camera timing purposes is provided by Ferree,[76] while Erickson[77] gives a general description of circuit requirements to provide timing marks in the range from 2000 to 8000 frames/sec. He also discusses increases in firing potential required when operating the NE-51 neon bulb in total darkness.

Bondelid[78] describes an improved version of a powered camera tracking mount previously described[79] as used in ballistic free-flight instrumentation. The mount carries 16mm and 35mm normal and high-speed motion-picture cameras photographing through new 24-in. and 48-in. $f/8$ refractor lenses which resolve about 200 lines/mm on their optical axes.

Sensitometry of short exposures was discussed by Castle and Webb[80] and by Tupper,[81] indicating continued interest in reciprocity-law failure effects in short-duration exposures.

Numerous applications of high-speed photography were cited during 1953. Photography of arcs and flames emitting high-intensity light was described by Stubbs, Rothschild and Moen[82] and by Stern and Foster.[83] Use of high-speed photography in rocket and jet propulsion studies was described by Stratton and Stehling[84] and by Berman and Scharres.[85] The latter paper discusses several types of American and European high-speed cameras, including the new Warrick streak cameras which transport 35mm film up to 125 ft/sec; the Acmade full-frame 35mm camera holding 200 ft of film and operating up to 2000 frames/sec; the M.G.D. 80-lens cameras taking a total of 750 pictures at rates up to 100,000/sec; and British developments in the image converter tube field.

Photography of high-voltage electrical arcs by the Bonneville Power Administration was described by Harrington and Ramberg[86]; Blunt[87] described high-speed photographic instrumentation of large underground explosions conducted in Utah; Brown[88] outlined use of high-speed flash in securing records of aerodynamic patterns in a wind tunnel using smoke trails; and Johnson[89] described high-speed photographic recording in the textile and black-powder wrapping fields. Waddell[90] outlined general procedures in the photography of motion; while Wilkinson and Romig[91] explained the simultaneous use of several

high-speed cameras to cover the time intervals between pictures provided by any one camera.

A thorough introduction to the schlieren, shadowgraph, and interferometer techniques is provided by Barnes,[92] who incorporates a bibliography of 219 references in his paper.

Clason[93] explained the use of conventional photoflash bulbs to illuminate a gun-fired projectile for photography at 6000 frames/sec in tests conducted by NACA. The use of high-intensity, high-speed repetitive flash illumination is described by Fristrom.[94]

An image-transport disc camera operating at 100,000 frames/sec and yielding 8mm motion pictures in a form suitable for normal projection is described by Miller and Scharf.[95] Other forms of ultra-high-speed photography applied to the study of explosions are well outlined by Sultanoff,[96] citing examples of work done at Aberdeen Proving Ground using streak, single-exposure, and high-speed motion-picture cameras.

Armed Services

The United States Air Force has made extensive use of kinescope recordings and television for training-film purposes. Approximately 125 kinescope productions were made during 1953, utilizing more than 170,000 ft of film. Television was also used by the Air Defense Command in televising weather information to pilots.

The Signal Corps is evaluating the applicability of television for use by the Army. The Human Resources Research Office of George Washington University is making the evaluations. The Signal Corps Mobile Television System is conducting a series of studies involving training and tactical applications of television. The Signal Corps has also a tactical television system using miniaturized equipment mounted in tactical vehicles and airborne equipment.

The United States Navy is conducting tests of underwater television kinescope recordings while the Bureau of Ships has developed underwater television camera equipment for such studies. Underwater illumination is furnished by specially developed mercury and xenon arc sources. The Naval Photographic Center has developed improved kinescope recording equipment and techniques for these applications. Rapid and unpredictable changes in subject brightness and contrast make desirable the use of film of greater latitude and higher speed than commonly used.

A high-speed facsimile system which transmits and receives at the rate of ten letter-size pages per minute has been designed by the Navy Bureau of Ships and developed by the Radio Corp. of America, in conjunction with the Haloid Corp. The copy to be transmitted is picked up by a flying-spot scanner, and the received copy is reproduced by the automatic continuous xerographic process. Rapid processing machines for aerial roll film and paper, for 70mm, 35mm and 16mm film are now in production. Naval photographic processing is being changed over to continuous rapid machine processing.

The Army Pictorial Center has developed a technique of recording on loops of magnetic film which has greatly simplified the "lip synchronization" of foreign languages to Army training films (see the paper on this subject soon to be published in the *Journal*). The Naval Ordnance Test Station has developed a versatile tracking camera which is mounted as an independent unit, supplying its own power, and capable of negotiating heavy sand. A new tracking telescope type of optical recording instrument has been produced at the White Sands Proving Ground by the Army for missile programs. Its flexibility permits the use of different cameras and optical systems, and its use as a cine-theodolite of moderate precision.

Color Television

The NTSC compatible color television system made great development in 1953 under the continued direction of the various panels of the National Television System Committee.

An NTSC color television demonstration was presented at the Hotel Waldorf-Astoria, New York City, in October 1953, where 13 color television receivers, as produced in the United States, were placed in operation. The color pictures were viewed by many engineers, the press, industry leaders and others who are interested in the color television development.

Late in 1953 the FCC approved the NTSC method, reversing its earlier approval of the CBS field-sequential system.

NBC has been transmitting several of its regular shows in color. The transmissions have been picked up with excellent quality on standard black-and-white receivers. The RCA color cameras used were equipped with three image-orthicon tubes, one for each of the primary colors. A one-tube camera is under development by RCA. CBS has developed a color camera which uses a single tube operating on a field-sequential basis with a rotating filter-wheel behind the lens. The signal then goes to a "chromacoder," a device which translates the signal into the NTSC standard.

One of the techniques making up the NTSC system is described in the FCC Report and Order as follows: "(It) relates to the demonstrated fact that the eye is much less sensitive to changes in hue and saturation in small areas than it is to changes in brightness. The corollary is that as the size of the viewed object is reduced, the eye becomes progressively color-blind so that ability to distinguish hue deteriorates. It follows that the color components of a picture can be transmitted over a narrow band of frequencies since resolution of fine detail is a function of bandwidth. In the NTSC system faithful colors are transmitted over a 0.06-mc bandwidth while the monochrome or luminance signal is transmitted over a 4.2-mc bandwidth. In between is a twilight zone where adulterated colors are transmitted. Thus, faithful colors appear in the coarse areas of the picture, adulterated colors in the medium-fine detail and only monochrome in the finest detail of the picture. The saving of frequencies resulting from the use of this technique is obtained at a cost in terms of the adverse impact on picture quality, but as indicated below, the overall result meets minimum standards of acceptability."

Studio experience in television color program production indicates that lighting will be simplified over what it has been heretofore. Lower color temperatures will be needed — 2900 to 3200 K is expected to be standard. This means that color television can use standard tungsten light sources and will not require the radical changes in studio lighting which were necessary when Technicolor, for example, entered the motion-picture studio. Levels will, of course, be considerably above those required for black-and-white television.

"Electronic Photography" in Color and Black-and-White on Magnetic Tape

Recording of television pictures on magnetic tape in color and black-and-white was demonstrated by RCA on December 1, 1953.[97] Thin, half-inch wide, magnetic-coated plastic tape, running at 30 ft/sec, was used for the color demonstration.

Seventeen-inch diameter reels recorded 4 min of television program. Five parallel recordings were made on the single tape, one for each of the red, green and blue primary color signals, the fourth for the synchronizing signal and the fifth for sound. A $\frac{1}{4}$-in. wide tape is sufficient for black-and-white recording.

Telemeter

The Telemeter system of pay-as-you-see television, developed by the International Telemeter Corp., started commercial operation in Palm Springs, Calif., on November 28, 1953. A special Telemeter channel, carrying the best in motion-picture entertainment and sports, was added to the free Los Angeles television distributed by the Palm Springs community system.

In building the Palm Springs community television system, ITC was led to develop its own line of broad-band VHF amplifiers and accessory community television equipment, since the equipment then commercially available was unable to do an adequate job. This community television equipment developed by ITC was marketed under the name of Ampli-Vision in the latter part of 1953.

Kinescope Recording

On the West Coast, kinescope recording increased in amount for programs delayed three hours in presentation.[98] 35mm kinescope recording has also increased in New York for prerecorded network shows which are reproduced from the kinescope negative.

Improved black-and-white kinescope recordings are being obtained by using ultraviolet light produced by a special phosphor and recorded on a specially prepared photographic emulsion. Some stations are changing from 5-in. to 10-in. recording kinescopes to obtain a greater ratio of image size to phosphor grain size and reduce eyestrain. Gamma-correction circuits are being used to render more detail in face tones and black areas.

A new field for kinescope recording is developing as colleges and universities develop plans for an educational film network to facilitate the interchange of program material.

Film Production for Television

The iconoscope has continued to be the "work-horse" for motion-picture film reproduction, although a few stations use the image orthicon for this purpose.[99] There have been, however, several notable developments in electrical and mechanical design which indicate that the flying-spot scanner and the vidicon tube will soon be widely used for film reproduction and that continuous-motion projectors may also play an important part in color television film reproduction.

The Philco Model FSS-5 Television Film Scanner[100] is a 35mm continuous-motion projector mechanism employing a 24-faced rotating prism and a flying-spot scanning system. It may be used for monochrome television, or by the addition of a "color head" it becomes suitable for use with color television. A shrinkage compensator permits adjustment for films of varying pitch.

The Du Mont Multiscanner[101] is a versatile and ingenious device employing a centrally positioned flying-spot cathode-ray tube whose light output is optically multiplexed to two motion-picture film handling machines and two opaque slide or baloptican picture holders. These four picture sources can simultaneously produce independent television images by means of their respective multiplier phototubes, all of which receive light from the same flying-spot source. A special 16mm film handling machine known as the "cinecon" has been designed specifically for use with this system. It is a continuous-motion machine resembling in external appearance a conventional projector, but employing a 24-faced rotating prism and having, in place of the lamphouse, a multiplier phototube which produces the monochrome electronic picture image.

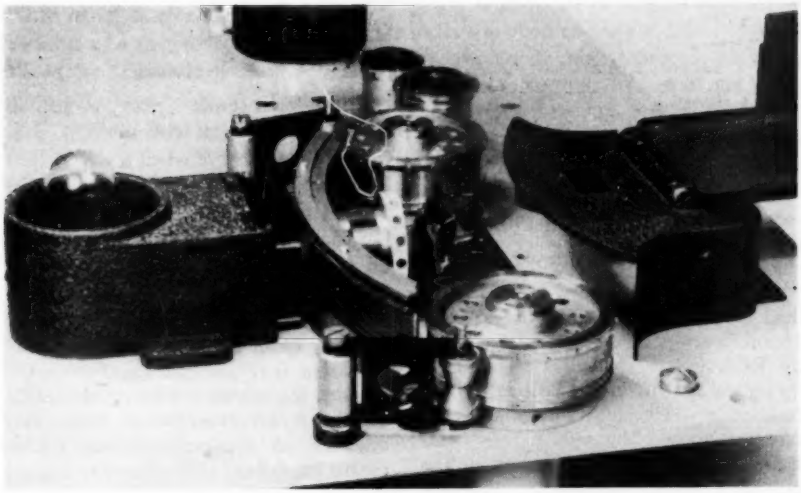

Fig. 14. Askania 16mm television projector of the nonintermittent type with optical compensation by means of a rotating prism.

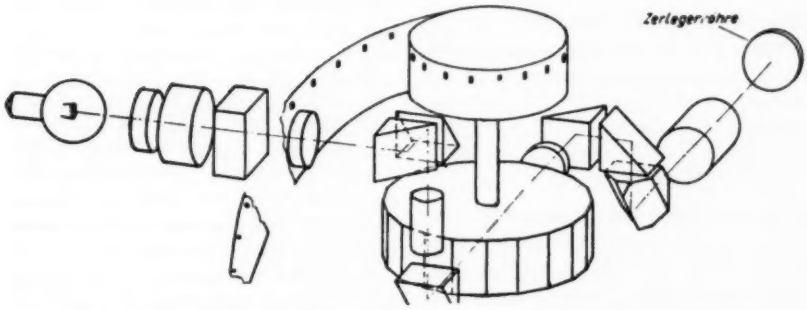

Fig. 15. Schematic of the Askania continuous-motion television projector.

Motorola, Inc., has devised a continuous all-electronic scanner for 16mm color motion-picture film which operates on a different principle.[102] No rotating prisms or mirrors are used. A "jump-scan" technique is employed wherein the vertical deflection of the cathode-ray tube forming the flying-spot light source is shifted by an amount equal and opposite to the film travel, thereby electrically immobilizing any given spot on the film. Since a ratio of 2 to 5 is required to convert 24 film frames to 60 television fields per second, one film frame will receive 3 jump-scans, while the next film frame will receive 2 jump-scans, thus making a total of 5 jump-scans for 2 film frames. The flying-spot

beam then returns to its original position on the face of the cathode-ray tube to begin another cycle. Servomechanisms are used to remove picture instability. Thyratron tubes triggered by television vertical synchronizing pulses provide the nonsynchronous power for the main drive motor. Dichroic mirrors divert the flying-spot light beam to the respective photomultiplier tubes for color reproduction.

An important development in the field of intermittent projectors was the 16mm fast pulldown projector developed by RCA for use in color television.[103] By means of a three-pointed star Geneva coupled in series with a shuttle-and-claw type intermittent through a 3-to-1 gear train, it was possible to achieve film pulldown during television blanking time, a period about 1250 μsec in duration. This extremely fast pulldown permitted the use of a flying-spot scanning system utilizing a color diplexer.

16mm Projector for Television

Three new 16mm projectors for full-storage operation were described in the *Journal*. The General Electric projector uses a gas-discharge tube[104] while the new RCA[105] and Eastman Kodak[106] projectors use a tungsten source.

16mm Television Film Equipment

The Ernst Leitz Co. in Wetzlar, Germany, further improved their 16mm professional projector, Model Leitz G-1, for television use. A Geneva movement with steadiness better than 0.1% is reported. A synchronized motor with special optics and still-projection equipment permit the projector to cover a variety of pickup tubes and to be used for straight projection. A 2½-hr continuous running time with 4500-ft magazines is reported with top film reel running vertically.

Askania[107] of Berlin has brought out a 16mm television projector of the non-intermittent type with optical compensation by means of a rotating prism (Figs. 14, 15).

Television Rear Projection

Television studio rear projection reached a new peak with the NBC production of *Richard II* when a screen 15 ft high and 60 ft long was used. This was illuminated by two 90-amp arc slide projectors using 4 × 5 in. slides made on a new heat-resistant glass. NBC has put a new type of screen into use made of blue latex rubber which has better diffusing quality than any before in use. It is said that one can stand at a 45° angle to this screen and see no noticeable difference in illumination from that observed at the perpendicular. This means less fall-off of illumination around the sides of the screen and a greater flexibility in the use of angle shots from widely spaced camera positions.

Television Studio Techniques

Television manufacturers came out last year with several very small television cameras — so small as to be almost in the size and weight class of 16mm movie cameras. Although this equipment was intended for industrial use, many broadcasters were immediately interested because of the exceedingly low cost. By year's end, over fifty broadcasting stations were using these cameras built around RCA's vidicon tube.

RCA put a 4-lb vidicon camera on the market which retails for under a thousand dollars. More useful for the broadcaster was the Dage camera (manufactured by Dage in Indianapolis, and also sold by Du Mont as the "tel-eye"). This camera, the size of a brief case, is a complete camera chain in itself, into which have been incorporated camera and viewfinder, camera control unit, power supply and synchronizing pulse generator. It puts out an rf signal which can be tuned to one of several standard television channels and fed directly to the antenna terminals

of any standard receiver. The General Precision Laboratory staticon, built around the English staticon tube, is also competing in this field.

Less sensitive than the image orthicon, the vidicon is not capable of the same resolution and picture quality, but on the other hand does not exhibit halo, streaking and other image-orthicon faults, and does not burn in a picture if left on a static scene. This has been particularly interesting to broadcasters since it means the camera can be left unattended.

The vidicon tube has also been incorporated into a new and improved film-pickup camera now offered by RCA. It is expected to replace the iconoscope tube for film pickup and rival the flying-spot scanner.

The German Television Society in Darmstadt has developed a very small light-weight image-orthicon tube.

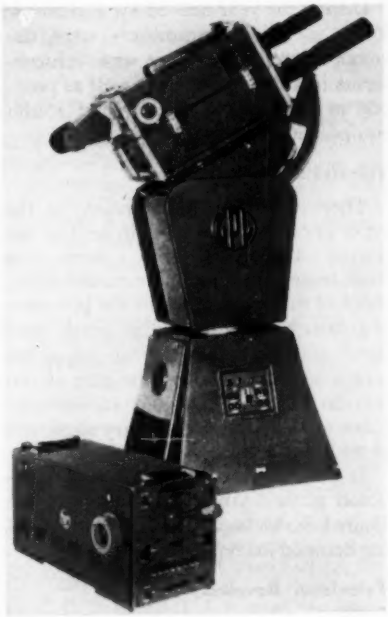

Fig. 16. The GPL Model PA-870 television camera pedestal showing remote-control components.

Television Equipment

General Precision Laboratory developed a television camera pedestal with remote control of pan and tilt movement (Fig. 16). Rate and position control of both pan and tilt as well as six preset pan and tilt positions are provided. Pan through 280° and tilt through 63° are provided. With suitable remote focus and lens-change facilities on the camera, the choice of lens and focus can be preset. The pedestal can be remote-controlled.

35mm television background and film-chain projector Models PA-200 and PA-201: Recent experience in television film systems indicates that quality improvement is obtained by operating vidicons and image orthicons with the longest available light pulse. The GPL 35mm film-chain projector has a 2:3 intermittent which is sufficiently fast to permit the use of a 40% open shutter. When equipped with an arc lamp, this machine is useful for television background projection and when equipped with smaller light sources, it is suitable for film-chain applications with any of the commonly used pickup tubes. Current experiments show the same high-quality performance with film chains for NTSC color transmission.

Television Broadcasting Stations

Television broadcasting in the United States made tremendous strides in 1953. There were 250 additional television stations added before the end of 1953, some of these being equipped for operation in the 470- to 890-mc UHF region. Four of the new stations are educational outlets.

During the year new 25-kw and 50-kw VHF television transmitters were developed, and there were new achievements in antenna design as well as progress in the field of camera and studio equipment.

Television Picture Tubes

There was some improvement in the types of cathode-ray tubes in general use during 1953. Generally, there was some improvement in more careful alignment of tube structures, in the provision of greater resolution, reduced beam "spot size," and the greater overall use of the screen surface. During the first eleven months of 1953, 9,194,851 cathode-ray tubes were sold in this country to owners of television receivers.

It was felt that the future use of television picture tubes will increase in the United States because of the now growing demand for replacement tubes.

Television Receivers

There were 5,600,423 television receivers sold through retail outlets in the United States in 1953. There was considerable improvement in these receivers because of the use of advanced circuitry, synchronization, improved picture definition, improvement in noise figure, etc. The 21-in. cathode-ray tube continued to be used this year as the outstanding picture-tube size accepted.

Some progress was made during the year in the production of UHF converters, receivers, antennas and tuners. These were designed for use in the new 470- to 890-mc/sec UHF broadcast band.

Television in Schools

The installation of studio equipment in schools and universities has proceeded at a rapid rate, and today approximately 20 schools are equipped to teach television with standard broadcasting equipment. Nearly a hundred schools of higher education have courses in television program production listed in their curricula. Many of the schools which have campus studios originate regular programs which are relayed to local television stations for broadcast.

Three new educational television stations went on the air during the last year, and 29 more have construction permits and are expected to be ready for broadcasting soon. Forty-five noncommercial applications have been filed.

Miscellaneous Television

A special device for the remote television transmission of surgical operations was developed in Germany, using a specially designed ring-type lighting equipment.[108] The German Television Society in Darmstadt has proposed a means of transmitting television pictures in 3-D using Polaroid foils.[109]

Conclusion

The above represents an incomplete but significant review of the progress during 1953 in motion-picture and television technology. The chairman of the committee wishes to express his thanks to the committee for their valuable contributions and to the following for special reports:

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REFERENCES

1. John A. Norling, "The stereoscopic art," *PSA Jour.*, Dec. 1951, reprinted in *Jour. SMPTE, 60:* 268–308, Mar. 1953.
2. Arthur Gavin, "All Hollywood studios shooting 3-D films," *Am. Cinemat., 34:* 108, Mar. 1953.
3. "Columbia Studio's 3-D camera," *Am. Cinemat., 34:* 215, May 1953.
4. F. A. Ramsdell, U.S. Pat. 2,630,737, Mar. 10, 1953.
5. *Third-Dimensional Camera Dial*, Bulletin 225-58.500-12, Motion Picture Research Council, Inc., Hollywood, Calif.
6. Armin J. Hill, "A mathematical and experimental foundation for stereoscopic photography," *Jour. SMPTE, 61:* 461–486, Oct. 1953.
7. Armin J. Hill, "The Motion Picture Research Council 3-D Calculator," *Am. Cinemat., 34:* 373, Aug. 1953.
8. W. A. Shurcliff, "Screens for 3-D and their effect on polarization," *Jour. SMPTE, 62:* 125–133, Feb. 1954.
9. *Progress Report on All-Purpose Theatre Screens*, Information Bulletin No. 7, Motion Picture Research Council, Inc., Hollywood, Calif., Aug. 5, 1953.
10. Armin J. Hill, "A first-order theory of diffuse reflecting and transmitting surfaces," *Jour. SMPTE, 61:* 19–23, July 1953.
11. Ellis W. D'Arcy and Gerhard Lessman, "Objective evaluation of projection screens," *Jour. SMPTE, 61:* 702–720, Dec. 1953.
12. E. H. Land, on "Three-dimensional presentation with polarized light," presented at the October 16, 1953, session of the American Optical Society Meeting in Rochester, N. Y.
13. L. W. Chubb, D. S. Grey, E. R. Blout and E. H. Land, "Properties of polarizers for filters and viewers for 3-D motion pictures," *Jour. SMPTE, 62:* 120–124, Feb. 1954.
14. R. C. Jones and W. A. Shurcliff, "Equipment to measure and control synchronization errors in 3-D projection," *Jour. SPMTE, 62:* 134–141, Feb. 1954.
15. "Zweibandverfahren auf dem Bauer-Selecton 110," *Kinotechnik:* 300, Oct. 1953.
16. Henry Dain, "Widening the field of camera lenses and on the use of normal films for the panoramic screen," *Jour. SMPE, 19:* 522–527, Dec. 1932.
17. A. Gillett, H. Chretien and J. Tedesco, "The panoramic screen projection equipment used at the Palace of Light at the International Exposition (Paris 1937), *Jour. SMPE, 32:* 530–534, May 1939.
18. James R. Benford, "The CinemaScope optical system," *Jour. SMPTE, 62:* 64–70, Jan. 1954.
19. Lorin D. Grignon, "Experiment in stereophonic sound," *Jour. SMPTE, 61:* 364–379, Sept. 1953, Pt. II.
20. Harvey Fletcher, "Basic requirements for auditory perspective," *Jour. SMPTE, 61:* 415–419, Sept. 1953, Pt. II (reprinted from *Bell System Tech. J., 13:* 239–244, Apr. 1934).
21. J. C. Steinberg and W. B. Snow, "Physical factors in auditory perspective," *Jour. SMPTE, 61:* 420–430, Sept. 1953, Pt. II (reprinted from *Bell System Tech. J., 13:* 245–258, Apr. 1934).
22. William B. Snow, "Basic principles of stereophonic sound," *Jour. SMPTE, 61:* 567–589, Nov. 1953.
23. American Standard Dimensions for 35mm Motion Picture Film—Alternate Standards for Either Positive or Negative Raw Stock, PH22.1-1953, *Jour. SMPTE, 60:* 66, Jan. 1953.
24. Proposed American Standard Dimensions for 35mm Motion-Picture Positive Raw Stock, PH22.36-1954, *Jour. SMPTE, 62:* 390, May 1954.
25. C. C. Davis and H. A. Manley, "Auxiliary multitrack magnetic sound reproducer," *Jour. SMPTE, 62:* 208–214, Mar. 1954.
26. J. D. Phyfe and C. E. Hittle, "A film-pulled, theater-type, magnetic sound reproducer for use with multitrack films," *Jour. SMPTE, 62:* 215–220, Mar. 1954.
27. S. W. Athey, Willy Borberg and R. A. White, "Four-track, magnetic theater sound reproducer for composite films," *Jour. SMPTE, 62:* 221–227, Mar. 1954.
28. C. C. Davis, J. G. Frayne and E. W. Templin, "Multichannel magnetic film recording and reproducing unit," *Jour. SMPTE, 58:* 105–118, Feb. 1952.
29. Leo Busch, "Zur ersten deutschen Cinema-Scope-Vorführung," *Kinotechnik:* 264–266, Sept. 1953.
30. John R. Bishop and Loren L. Ryder, "Paramount's Lazy 8 Double-Frame Camera," *Am. Cinemat., 34:* 588, Dec. 1953.
31. Chester, B. Bahn, "A review . . . C-Scope leads new methods," *The Film Daily:* 4, Jan. 5, 1954.
32. *Jour. SMPTE, 61:* 210, Aug. 1953.
33. Rudolf Frerichs, "New optical glasses with good transparency in the infrared," *J. Opt. Soc. Am., 43:* 1153–1157, Dec. 1953.
34. W. A. Fraser and J. Jerger, "Arsenic trisulfide. A new infrared transmitting

glass," *J. Opt. Soc. Am., 43:* 332, Apr. 1953.
35. H. E. Bauer and A. W. Blake, "Application of wide-angle optics to moderately high-speed motion-picture cameras," *Jour. SMPTE, 60:* 38–46, Jan. 1953.
36. J. R. Benford, "The CinemaScope optical system," *Jour. SMPTE, 62:* 64–70, Jan. 1954.
37. Louis Hochman, "Here is CinemaScope," *U.S. Camera, 32:* 72, June 1953.
38. "Bell & Howell Make X 'Scope Lenses,' " *Intl. Projectionist, 28:* 38, Dec. 1953.
39. Lew Parrella, "Coming soon — wide screen for 16mm movies," *U.S. Camera, 16:* 64–66, Oct. 1953.
40. *PSA Jour., 19:* 8, July 1953.
41. "Philips-Schmaltonfilmprojektor 16mm Cinema Typ El-5000," *Kinotechnik:* 256, Sept. 1953.
42. W. T. Hanson, Jr., and W. I. Kisner, "Improved color films for color motion-picture production," *Jour. SMPTE, 61:* 667–701, Dec. 1953.
43. C. R. Anderson, C. E. Osborne, F. A. Richey and W. L. Swift, "Sensitometry of the color internegative process." (Presented Oct. 8, 1953, at the Society's Convention in New York. To be published.)
44. R. M. Evans and W. L. Brewer, "The first and second black conditions." (Presented Oct. 8, 1953, at the Society's Convention in New York.)
45. F. J. Kolb, Jr., "Specifying and measuring the brightness of motion-picture screens," *Jour. SMPTE, 61:* 533–556, Oct. 1953.
46. A. A. Rasch and J. I. Crabtree, "Development of motion-picture positive film by vanadous ion," *Jour. SMPTE, 62:* 1–10, Jan. 1954.
47. A. M. Koerner, "The problems of control of the color photographic processes." (Presented Apr. 30, 1953, at the Society's Convention at Los Angeles.)
48. D. L. MacAdam, "Stereoscopic perceptions of size, shape, distance and direction," *Jour. SMPTE, 62:* 271–293, Apr. 1954.
49. W. R. J. Brown, "A rapid-scanning microdensitometer." (Presented Oct. 6, 1953, at the Society's Convention at New York.)
50. R. W. Wengel, "A pneumatic pulldown 16mm projector." (Presented Oct. 7, 1953, at the Society's Convention at New York.)
51. A. F. Sorem, "The effect of camera exposure on the tone-reproduction quality of motion pictures," *Jour. SMPTE, 62:* 24–44, Jan. 1954.
52. D. L. MacAdam, "Reproduction of colors in outdoor scenes," *Proc. IRE, 42:* 166–173, Jan. 1954.
53. W. L. Brewer, J. H. Ladd and J. E. Pinney, "Brightness modulation for television color film," *Proc. IRE, 42:* 174–191, Jan. 1954.
54. S. A. Powers and E. K. Letzer, abstracts of a paper by each on "Application of interference filters in color densitometry," *J. Opt. Soc. Am., 43:* 332, Apr. 1953.
55. G. R. Crane, Fred Hauser and H. A. Manley, "Westrex Film Editer," *Jour. SMPTE, 61:* 316–323, Sept. 1953.
56. "Optische Tonumkopiermaschine," *Kinotechnik:* 332, Nov. 1953; "Pernutz sorgt für gleichmässige Umkehrfilm-Entwicklung," *ibid.*, 170, June 1953.
57. H. Meyer, "Nonphotographic aspects of motion picture production," *Jour. SMPTE, 57:* 54 ff., July 1951.
58. *Chemical Week:* Apr. 4, 1953.
59. H. Greutert, *Plastic Newsfront:* 3–9, Oct. 1953.
60. *Plastic World, 11-12:* 1, 6, 7, Dec. 1953.
61. Frank F. Crandell and Karl Freund, "Photoelectric brightness spot meter," *Jour. SMPTE, 61:* 215–222, Aug. 1953.
62. George A. Jones, *High-Speed Photography*, John Wiley & Sons, New York, 1952.
63. "Bibliography on high-speed photography," *Jour. SMPTE, 61:* 749–757, Dec. 1953.
64. W. Deryck Chesterman, "History and present position of high-speed photography in Great Britain," *Jour. SMPTE, 60:* 240–246, 36 refs., Mar. 1953.
65. P. Fayolle and P. Naslin, "Simple electronic devices for high-speed photography and cinematography," *Jour. SMPTE, 60:* 603–626, 11 refs., May 1953.
66. Hubert Schardin, "The development of high-speed photography in Europe," *Jour. SMPTE, 61:* 273–285, 5 ref., Sept. 1953.
67. J. S. Courtney-Pratt, "Fast multiple frame photography," *J. Photographic Sci., 1* (Section B of *The Photographic Journal*): 21–40, 99 refs., Jan.-Feb. 1953.
68. John H. Waddell, "Full-frame 35mm Fastax camera," *Jour. SMPTE, 61:* 624–627, Nov. 1953.
69. Charles A. Hulcher, "Rapid-sequence camera using 70mm film," *Jour. SMPTE, 60:* 247–252, Mar. 1953.
70. S. A. Weinberg, J. S. Watson and G. H. Ramsey, "X-ray motion picture camera and printer for 70mm film," *Jour. SMPTE, 60:* 31–37, 4 refs., Jan. 1953.
71. Charles T. Lakin, "70mm test vehicle recorder," *Jour. SMPTE, 60:* 671–674, *June* 1953.
72. Donald J. Southard, "A dual lens system for a radar boresight tracking camera," *Phot. Eng., 4, No. 3:* 142–145, 1953.
73. Harold E. Edgerton and Kenneth J. Germeshausen, "A microsecond still

camera," *Jour. SMPTE, 61:* 286–294 Sept. 1953.
74. Harold E. Edgerton and Charles W. Wyckoff, "A rapid-action shutter with no moving parts, " *Jour. SMPTE, 56:* 398–406, 5 refs., Apr. 1951.
75. Sidney M. Lipton and Kennard R. Saffer, "The BRL-NGF cinetheodolite," *Jour. SMPTE, 61:* 33–44, July 1953.
76. H. M. Ferree, "Glow lamps for high-speed camera timing," *Jour. SMPTE, 61:* 742–748, 3 refs., Dec. 1953.
77. A. M. Erickson, "Photographic instrumentation of timing systems," *Jour. SMPTE, 61:* 165–174, Aug. 1953.
78. Myron A. Bondelid, "The M-45 tracking camera mount," *Jour. SMPTE, 61:* 175–182, Aug. 1953.
79. Carlos H. Elmer, "Photography in the rocket-test program," *Jour. SMPTE, 54:* 140–148, Feb. 1950.
80. J. Castle and J. H. Webb, "Results of very short-duration exposures for several fast photographic emulsions," *Phot. Eng., 4, No. 2:* 51–59, 1953.
81. J. L. Tupper, "Practical aspects of reciprocity-law failure," *Jour. SMPTE, 60:* 20–29, Jan. 1953.
82. W. B. Stubbs, G. R. Rothschild and W. B. Moen, "Photography of arcs and flames emitting high-intensity light," *Phot. Eng., 4, No. 2:* 95–103, 1953.
83. I. L. Stern and John H. Foster, "High-speed photographic techniques for the study of the welding arc," *Jour. SMPTE, 60:* 400–404, Apr. 1953.
84. Floyd G. Stratton and Kurt R. Stehling, "Applications of high-speed photography in rocket motor research," *Jour. SMPTE, 60:* 597–602, 4 refs., May 1953.
85. Kurt Berman and Edward H. Scharres, "Photographic techniques in jet propulsion studies," *J. Am. Rocket Soc., 23:* 170–173, 41 refs., May-June 1953.
86. Everett J. Harrington and Harold C. Ramberg, "High-speed motion-picture photography of electrical arcs on a high-voltage power system," *Jour. SMPTE, 60:* 675–679, June 1953.
87. R. M. Blunt, "Use of photography in the underground explosion test program, 1951–1952," *Jour. SMPTE, 60:* 405–417, Apr. 1953.
88. F. N. M. Brown, "A photographic technique for the mensuration and evaluation of aerodynamic patterns," *Phot. Eng., 4, No. 3:* 146–156, 1953.
89. W. O. S. Johnson, "High-speed photography in the chemical industry," *Jour. SMPTE, 61:* 619–623, Nov. 1953.
90. John H. Waddell, "Photography of motion," *Jour. SMPTE, 61:* 24–32, July 1953.
91. R. I. Wilkinson and H. G. Romig, "Random picture spacing with multiple camera installations," *Jour. SMPTE, 61:* 605–618, Nov. 1953.
92. Norman F. Barnes, "Optical techniques for fluid flow," *Jour. SMPTE, 61:* 487–511, 219 refs., Oct. 1953.
93. Harry C. Clason, "A method of lighting large fields for high-speed motion picture photography," *Jour. SMPTE, 60:* 30, Jan. 1953.
94. R. M. Fristrom, "The ballistic switch: a means to high-intensity high-speed repetitive illumination," *Phot. Eng., 4, No. 2:* 74–76, 1953.
95. C. David Miller and Arthur Scharf, "Isotransport camera for 100,000 frames per second," *Jour. SMPTE, 60:* 130–144, Feb. 1953.
96. Morton Sultanoff, "Photographic instrumentation in the study of explosive reactions," *Jour. SMPTE, 60:* 145–165, 8 refs., Feb. 1953.
97. *Jour. SMPTE, 62:* 100–102, Jan. 1954.
98. R. E. Lovell, "Time-zone delay of television programs by kinescope recording," *Jour. SMPTE, 60:* 235–239, Mar. 1953.
99. R. D. Chipp, "Film projection using image-orthicon cameras," *Jour. SMPTE, 60:* 1–8, Jan. 1953.
100. E. H. Traub, "New 35mm television film scanner," *Jour. SMPTE, 62:* 45–54, Jan. 1954.
101. J. H. Haines and G. R. Tingley, "The Multiscanner, a versatile flying-spot scanner," a technical paper presented to the NARTB Convention in Los Angeles, Apr. 1953.
102. V. Graziano and K. Schlesinger, "A continuous all-electronic scanner for 16mm color motion-picture film," *Jour. SMPTE, 62:* 294–305, Apr. 1954.
103. Warren R. Isom, "Fast-cycling intermittent for 16mm film," *Jour. SMPTE, 62:* 55–63, Jan. 1954.
104. R. E. Putman and E. H. Lederer, "Synchro-Lite powered projector," *Jour. SMPTE, 60:* 385–389, Apr. 1953.
105. W. E. Stewart, "New professional television projector," *Jour. SMPTE, 60:* 390–399, Apr. 1953.
106. Edwin C. Fritts, "16mm projector for full-storage operation with an iconoscope television camera," *Jour. SMPTE, 61:* 45–51, July 1953.
107. Johannes Schunack, "Ein Verfahren zur Abtastung von 16mm-Filmen," *Kinotechnik:* 320–321, Nov. 1953.
108. F. Guenther Hanau, "Eine Anlage zur Fernübertragung von Operationen," *Kinotechnik:* 319, Nov. 1953.
109. "Neues Verfahren zur stereoskopischen Übertragung in Fernsehen," *Kinotechnik:* 325, Nov. 1953.

Temperature-Sensitive Phosphors for the Evaluation of Air Jets Designed to Cool Motion-Picture Film

By F. J. KOLB, JR., and F. URBACH

In the projection of motion-picture film at high intensities for maximum screen illumination, it is sometimes desirable to cool the film and control its position with a blast of high velocity air. This paper presents a method for evaluating the design, placement, and operation of the jet which provides the cooling air. The heart of the method is the fact that the brightness of certain phosphors depends strongly on temperature. Such phosphors provide an immediate visual indication of the temperature distribution over the film face. Examples of several air flow patterns revealed by the use of phosphors are discussed. Test results obtained by projection of film are compared with predictions.

DEMANDS for higher light output from motion-picture projectors to supply the requirements of both the outdoor theaters and the larger indoor theaters, have emphasized the existence of limiting values of radiant flux beyond which film performance becomes unsatisfactory, and have focused attention upon means for increasing screen illumination without making additional demands upon the film. This situation has been reviewed more fully in a previous article[1] which discussed the behavior of motion-picture film under high radiant-flux densities, and considered several general approaches to the problem of keeping actual film temperatures below the critical threshold. This earlier paper pointed out that cooling the film in the aperture by streams of high-velocity air is one method of increasing the safe permissible maximum flux density, and therefore increasing total screen light.

In order to take advantage of air-cooling it is necessary to design jets which provide high-velocity air over the entire film surface exposed in the gate. It is the purpose of this paper to consider the problems of proper jet design, placement and operation.

Film in the aperture is able to lose some heat by radiation to cooler surroundings, by conduction to solid surfaces in direct contact with it, and by conduction into the air — which latter heat is carried away from the film sur-

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face by the air's convection currents. This convection cooling can be increased immensely by high-velocity jets, but their design is complicated by several restrictions. The jets must be entirely outside the cone of light illuminating the frame, they must not interefere with the essential elements of projector construction, they must cool an area not easily accessible and further surrounded by interfering shapes and objects, they must operate with as little noise as possible, and they must make reasonably efficient use of the air supplied. Determining whether the entire aperture is cooled satisfactorily or whether the most efficient cooling is being realized, requires the study of considerable amounts of film projected under varying conditions and examined carefully upon the screen. The time-consuming nature of this operation and the skill required in interpreting results have made it difficult to select the most promising jet designs from the multitude of possibilities that exist.

A Method of Solution

Design of air jets would be simplified greatly if the effects of changes could be assessed quickly and easily! A method for determining patterns of temperature distribution with the aid of temperature-sensitive phosphors, developed in the Kodak Research Laboratories,[4,5,6] was found to provide a suitable tool for a preliminary testing of air-jet designs. This method makes possible both visual observations of the effects of changes in design and photographic records of such patterns as are of most interest. By this procedure, the best nozzle designs and their best methods of operation can be established so that final evaluation of film performance need be made only on selected designs.

This method of jet evaluation was made possible by fundamental research on phosphors pursued diligently during the last decade and greatly stimulated by the military problems of the last war. As a by-product of that work a class of luminescent materials has been developed which shows a strong variation in visible emission* with temperature of the phosphor. The best of these materials — if excited to visible emission by ultraviolet radiation — show a degree of temperature dependence that makes them valuable indicators for determining the temperatures of surfaces to which the phosphors have been applied. Sensitivities can be increased so that a discernible difference can be shown easily for temperature changes as low as 1 C, or reduced manyfold for the study of temperature variations over a range of 100 C or more.

Applied to the engineering problem of determining proper jets for the air-cooling of motion-picture films, temperature-sensitive phosphors provide a ready evaluation and comprehensive understanding of the problem. The opportunities for visual appraisal of each change in design are especially important in making the method informative and time-saving.

Procedure

In order to complete a survey on the possibilities of cooling of film by high-velocity air a study of jet design was undertaken and an exploratory survey was made using temperature-sensitive phosphors. Two phases of the procedure for this survey are of interest because they illustrate proven methods of operation: the preparation of the phosphor and the development of suitable test apparatus.

The phosphors used in this investigation have been described and discussed from the point of view of their purely scientific and theoretical interest in several papers[2,3,6] and the application of such phosphors to the general problems of determining temperature distribution has been outlined.[4,5,7]

* Some phosphors in this class change the color of their emitted light with temperature, while others change their brightness only.

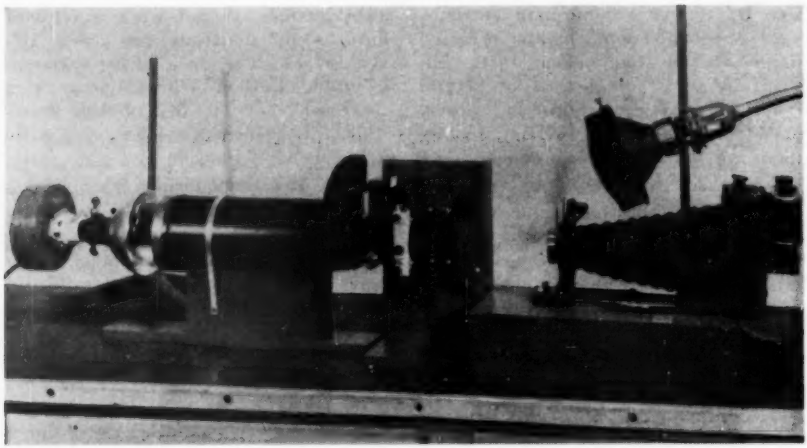


Fig. 1. Experimental setup for production and study of fluorescent patterns on air-cooled film.

The particular phosphors used in this investigation were zinc-cadmium sulfides activated by 400 parts per million (by weight) of silver together with three parts per million of nickel. With sufficiently intense ultraviolet excitation, these phosphors show a bright yellow emission whose intensity has a high temperature sensitivity between room temperature and about 250 F; a change in temperature of 1 C can produce a brightness change of up to 10% or 20%.

The finely divided phosphor was suspended in a nitrate lacquer, and spray-coated onto the base of a length of black film having an original density slightly over 3. In use the film was heated by the absorption of radiant energy in the black "image," while the fluorescence was examined from the opposite (base) side, screened from all ambient light. Film temperatures were maintained at approximately 230 F (approximately the maximum film temperature expected in some of the moderately large theater projectors) so that normal mechanisms of heat transfer from the film would prevail.

Obtaining suitable response from the phosphor requires a proper balance among (1) composition of the phosphor, (2) intensity of the ultraviolet excitation, (3) intensity of radiant flux supplying heat to the phosphor-coated film, and (4) efficiency of the cooling air flow operating to remove heat from the phosphor-coated film.

The response of these phosphors has been found to be a rather complicated function of the exciting ultraviolet intensity and of the temperature. Both the operating temperature range and the sensitivity of the phosphor depend upon this excitation; the useful temperature level is raised and the sensitivity decreased as the exciting illumination is increased.* Constant ultraviolet intensity was used throughout for convenience and simplification of the technique.

Final control of the phosphor indication was obtained by adjusting the film temperature to make the fluorescence pattern yield the most information. For

* In some applications this dependence requires much attention to the problem of securing sufficiently even ultraviolet intensity over the whole phosphor area, but no such difficulty arises with an area of only 0.5 sq in. to illuminate!

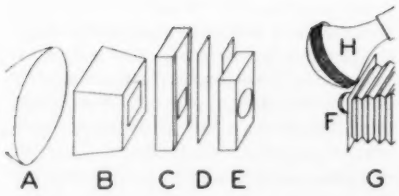


Fig. 2. Essential equipment of experimental setup shown opposite: (A) radiant energy source; (B) sight box and associated impediments to air flow; (C) film trap; (D) black film, coated with temperature-sensitive phosphor; (E) film-trap door; (F) ultraviolet-absorbing camera lens filter; (G) camera; and (H) ultraviolet light source.

example, a series of pictures at constant radiant flux but varying air flow from a given jet will show the change in film temperature resulting from the change in cooling, but any wide change will shift the fluorescent light so far toward high brightness or low brightness that the "tonal range" — the indication of temperature distribution — will be less extensive. If, on the other hand, the radiant flux heating the phosphor-coated film is changed with each change in air flow, it is possible to maintain at all flow rates a clear rendition of the detailed pattern of air flow at the expense of a ready comparison of film temperatures between flow rates. This simplified technique, therefore, allows either temperature level or distribution to be compared at will.

First interest in the design of air jets is usually in the detail of air flow and distribution. When all jets have been compared in this way, the better ones can then be compared at constant radiant flux to determine relative efficiencies of the jets.

Specific apparatus for the evaluation of air jets is shown in Fig. 1, and the components are identified in Fig. 2. While it is perfectly possible to use a complete projection mechanism, we found it more convenient to mount the film trap, baffles, fire shutter, etc, on a base plate duplicating the main frame casting, and to construct on this plate a nonoperating mock-up of the projector. The radiant flux was supplied by an incandescent lamp (a Photospot RSP-2 on variable voltage) located to give the proper energy distribution across the gate, and baffled so as not to contribute significantly to the general room illumination. The strip of black phosphor-coated 35mm film was held stationary in the gate. Ultraviolet excitation at 3650A was provided by a G. E. 100-w CH-4 projector spot lamp covered with a Corning No. 5874 filter and set about 15 in. from the phosphor-coated film, with the incident ultraviolet nearly normal to the film. A camera was set along the optic axis of the mock projector, to photograph the fluorescence pattern of the phosphor-coated film.

Uniform absorption was obtained over the entire frame by using a black strip of film — representative of very low-key photography and of the dense scenes that generally cause trouble first when film is overheated. The black, opaque frame together with the baffling of the incandescent lamp heating the film kept the incident light out of the room, and permitted convenient examination of the fluorescent image of the phosphor without the degradation of spill-light.

While the fluorescent pattern is visible with adequate contrast, a photograph taken without further precautions has its contrast greatly reduced by the actinic ultraviolet which floods the scene. Adequate photographs can be made only by equipping the camera with an ultraviolet-absorbing filter such as the Wratten No. 2B.

The mock projector as a first approximation has given useful results, even though there are obvious differences between film temperatures in the mock projector and film temperatures in an actual projector. This simplified apparatus used for convenience, however, comes closer

to reproducing the distribution of maximum temperatures in the film than might at first be assumed. Of primary importance to the basic problem of higher screen illumination is this level and distribution of maximum temperature in the film. As shown previously[1] the best information available indicates that this maximum occurs in the emulsion close to the emulsion-base interface, that it occurs at the end of the projection cycle just as the pulldown blade is about to interrupt the light, and that the temperature rise is extremely rapid.

The basic difference between the test conditions obtained on the mock projector and those on an actual projector is the substitution of steady-state heat flow for transient-state flow. The transient flow in the actual projector leads to the following conditions[1]: (1) heat input by absorption of radiant energy in the photographic image is so rapid that conduction even through the thickness of the film is negligible and the temperature rise of the base surface is insignificant; (2) conduction sidewise and heat flow from hot, dense areas of the image to clear areas or to surrounding film out of the light beam must be negligible also, because of the even greater ratio of path length to crosssection; (3) significant heat loss by both convection and radiation must occur from the emulsion surface only, since that surface rises rapidly to a high temperature and remains the only high-temperature surface during the projection interval.

The steady-state equilibrium in the mock projector, on the other hand, will be seen to lead to the following conditions: (1) the heat input by absorption of radiant energy in the black film is again limited to the image surface, but there is time for heat to be conducted away through the film in all directions; (2) if there were no heat loss at all from the base surface, then this surface (where our temperature-indicating phosphor is located) would reach a temperature identical with the emulsion surface, but this situation is never reached exactly since both surfaces lose heat at approximately equal rates by radiation, and the phosphor surface loses some further heat by convection cooling in the "still air" surrounding the base side of the film; however, the convection heat-loss from the emulsion surface under forced air-cooling is so much greater than that from the base in "still air," and at the temperature levels employed so much greater than the radiation loss, that as a first approximation *the most significant heat loss* is from the emulsion surface; (3) in the steady state there is time for heat conduction parallel to the face of the film to areas outside the light beam; because of the extreme thinness of motion-picture film and the distributed heat input over the entire frame area this is important only at the very edge of the aperture where the temperature gradient increases.

As a result the temperature contour of the base surface of film in the mock projector becomes nearly identical with the temperature contour of the emulsion surface. Since it is on this base surface that our temperature-sensitive phosphor is located, the result is that temperature pattern made visible by the phosphor is nearly equivalent to that on the emulsion surface of the test film — and this in turn has been shown nearly equivalent to the temperature pattern of transient maxima in black film in an actual projector.

By arbitrary choice of the intensity of incident radiation whose absorption is responsible for the heating of the film, this emulsion-surface temperature (and subsequently the phosphor temperature) is made to approximate reasonable film temperatures in normal projection. Therefore the temperatures indicated in the steady-state mock projector bear a close relationship to the significant temperatures of film in an actual projector — the relationship becoming more direct as the air cooling becomes more efficient.

The general correctness of this reasoning is shown by our success in appraising jets. We have found that those which look best in the phosphor evaluation also perform best in actual tests with moving film in a standard projector, thus establishing our own confidence in the validity of the phosphor indications.

Interpretation of the phosphor patterns was semiquantitative in this work, although it can be qualitative or precisely quantitative as the need and justification arise.[5] Fluorescence patterns represented by Fig. 4 and those following were examined visually or photographed for record without the calibration necessary to establish actual temperatures from the photograph. Decisions on the relative efficiencies of air jets, on the best methods of adjustment, and on the adequacy of frame coverage can be made from the qualitative observations of temperature distributions. In a serious program to design and use air cooling of motion-picture films, such a qualitative program is adequate to guide the work, suggest equipment developments and modifications, and speed progress materially.

It would be difficult in practice but perfectly possible theoretically to apply some of these same techniques to actual film moving at projection speeds through a standard projector. Under these conditions of course it would be desirable to determine actual temperatures.

Results and Examples

The work on jet design reported here is illustrative only and does not attempt to develop the optimum jet for any specific projector. As discussed earlier, this optimum will depend on structural features of the particular projector; it will also depend on how much modification of existing equipment the designer is willing to undertake in those instances where a compromise must be sought between several purposes.

Introductory studies of the phosphor technique were made on the air jet shown in Fig. 3, which earlier work[1] had

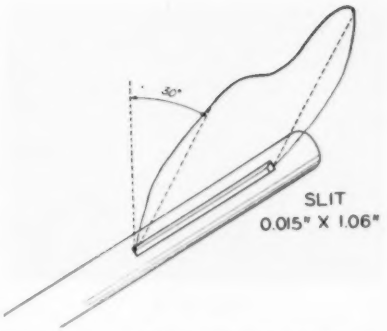


Fig. 3. Slit nozzle, showing slit dimensions and impingement angle.

shown to be reasonably efficient. This jet is a horizontal slit, directing a sheet of air upward and forward to hit the emulsion surface of the film near the horizontal centerline. Figures 4, 5 and 6 show the difference in the cooling pattern as the angle of the slit jet — and therefore both the angle of the air stream and its point of impact on the film — were varied.

Photographs of all phosphor patterns are positives: the lighter areas correspond to higher brightness (and lower temperature), the darker areas to lower brightness (and higher temperature). All these photographs are masked to show only the full-frame film area immediately in front of the projector aperture. The figures are right-side-up as viewed from the projection lens. The graininess visible in these photographs results from the granular nature of a spray coating of phosphor. This can be minimized further when necessary by more care in the preparation of phosphor coating. In these illustrations where the frame has been magnified several times it should be apparent that the grain pattern does not obscure the results.

In Figs. 4, 5 and 6 it will be seen that increasing the angle and lowering the line of impact moves the area of maximum cooling closer to the bottom frame-

Figure 4

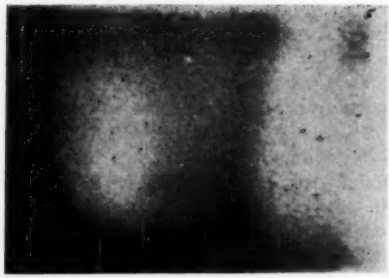


Figure 5

Figure 6

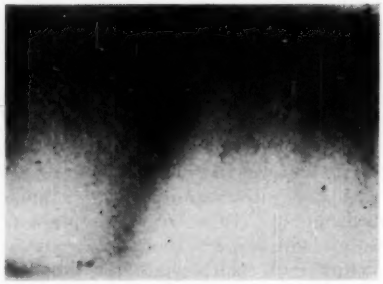


Figure 7

Figs. 4–7. Phosphor patterns: cooling pattern of slit nozzle, in impingement angle series, at 20° (Fig. 4), 30° (Fig. 5), 40° (Fig. 6), and 30° (Fig. 7). Figure 7 shows unnatural air flow resulting from removal of all structure around the gate but is otherwise comparable with Fig. 5.

line. Previous studies with film had shown an angle of 30° to be optimum for this particular jet and the phosphor patterns also show the best distribution for this setting.

Necessity for similitude between any mock projector that may be built for preliminary studies of cooling and the actual projector, can be shown by comparative phosphor patterns. Figures 4, 5 and 6 are made with care to duplicate exactly all the detail of the actual projector in the vicinity of the aperture. Figure 7, on the other hand, is comparable with Figure 5 except that the fire shutter, operating linkages, baffles, etc. that surround the aperture of an actual projector were removed from the mock projector. It is obvious that these elements — although not directly in the path of the air stream — modify the air flow away from the aperture and so change the resulting cooling. This is especially apparent from the reduced cooling in the upper right-hand corner (nontrack side) of the aperture.

Effect of air velocity on distribution is shown in Figs. 8, 9 and 10, taken at nozzle velocities of 240, 680, and 950 ft/sec respectively. These pictures were taken with the radiant flux heating the phosphor-coated film strip balanced to the air-cooling so that approximately constant detail appears on the phosphor.

Figure 8

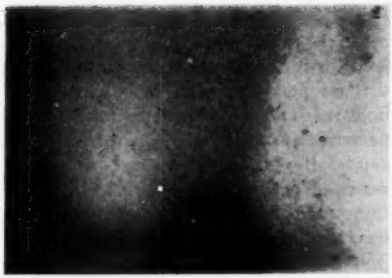


Figure 9

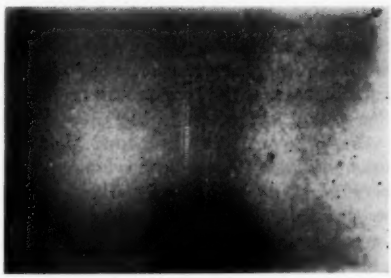


Figure 10

Figs. 8–10. Phosphor patterns: cooling pattern of slit nozzle, in air velocity series, at a jet velocity of 240 ft/sec (Fig. 8), 680 ft/sec (Fig. 9), and 950 ft/sec (Fig. 10).

The photographs show that there is remarkably little change in air pattern with velocity — a property which is very desirable for practical use, but which may not always be realized in a complex jet. The convention in these figures (as in the previous discussion of air-cooling)[1] is to report air velocities at the nozzle exit, which can be determined much more readily than velocities at the film surface. When the comparison is made for nozzles comparably mounted, this becomes almost as convenient a parameter as the actual velocities at the film.

Other jet designs became of interest as soon as we had thus examined the performance of an air jet of known properties. It will be noted in Figs. 8, 9 and 10 and in some of those earlier, that this slit jet does not cool both edges of the frame equally. Instead the velocity and efficiency at the soundtrack side are less because of the differences in static pressure acting along a slit of constant width, and because of the forward momentum of the air stream. The air stream is seen to sweep at an angle upward and to the right across the aperture, and to vary erratically along its length. These differences, plus the difficulties of cooling the lower frame edge suggested that improved performance could be expected from design changes.

It is interesting to note — and it is a main theme of this article — that such opportunities for improved performance were shown clearly and graphically by the phosphor study. Without the help of this tool, the opportunities could be inferred from a study of the projection behavior of film in actual projectors, but only laboriously and as the result of an extended study.

Several jet designs were examined to test the phosphor method and see what flow patterns would result. Figure 11 shows the extreme nonuniformity obtained from a wider slit whose area becomes larger with respect to the cross section of the supplying duct. Although the slit extends the full width of the aperture, only half of the film width is cooled effectively.

Among the other interesting variations is the pattern of Fig. 12, obtained from a jet similar to the above except that the slit has been replaced by a row of 17 holes of 0.040-in. diameter each. The pattern shows the same general variation caused by the difference in static pressure; in addition, there are local variations caused perhaps by burrs and defects around the circumference of individual holes.

When these holes are reduced in size to a row of 28, each only 0.019 in. in diameter, as in Fig. 13, every individual stream of air is so small in diameter that the $\frac{9}{16}$-in. path length from jet to film and the interference from neighboring jets breaks up the air pattern and reduces the cooling efficiency.

Aerodynamic design was approximated next, in order to see whether expected benefits would be realized, with the construction of a single jet resembling a venturi or turbine nozzle, which makes more efficient use of the energy in the air stream. Construction of this jet is shown in Fig. 14, and the completely different phosphor pattern resulting, in Fig. 15. Despite the restricted air source and the inability to place the jet in the optimum position because of interference from light cone, it will be seen that this is a remarkably successful cooling pattern. There has been so much recent work on the design of flow surfaces for aircraft turbines etc. that still more satisfactory cooling jets probably could be chosen.

There is one difference between the fluorescent pattern shown in this test and that which would result if the comparison had been made with moving film in an actual projector with a conventional lamphouse — and this difference is emphasized by Fig. 15. The heat input to stationary film in the mock projector is more uniformly distributed across the aperture than that produced by the mirror or condenser image of a carbon-arc crater, and what conduction

Figs. 11–13. Phosphor patterns: cooling pattern of nozzle with wide slit (Fig. 11); cooling pattern of perforate nozzle containing 17 holes each 0.040-in. diameter (Fig. 12); cooling pattern of perforate nozzle containing 28 holes each 0.019-in. diameter (Fig. 13).

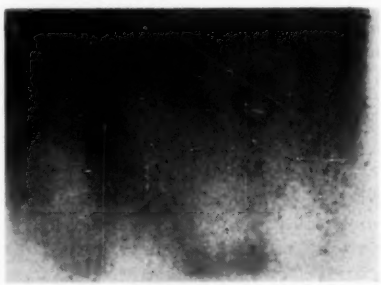


Figure 12

Figure 11

Figure 13

does occur in the steady-state model tends further to equalize the heating at the sides of the frame with that at the center. Thus, while Fig. 15 shows the film hotter at the frame edges and corners than at the center, because the cooling is less efficient at the edges than at the center, this temperature difference is reduced or reversed when film is projected with normal screen distribution — as is shown by the film testing of this jet. Actually this is the best cooling pattern obtained from any of the air jets studied because it is complementary to the heating pattern. It would of course be possible to adjust the intensity of the radiant energy heating various portions of the stationary fluorescent film in the mock projector to obtain distributions typical of theater projectors, and this might make the fluorescent patterns easier to judge. All the examples published herein, however, used uniform energy distribution instead.

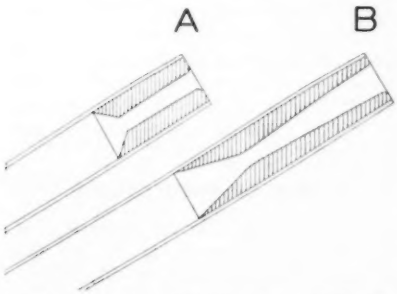
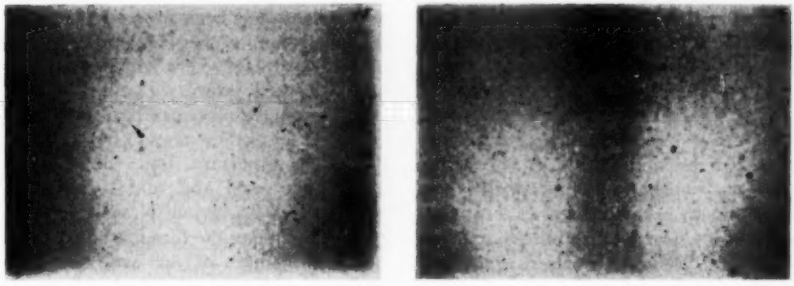


Fig. 14. Cross-section of aerodynamic jet, throat diameter 0.0952 in.: (A) as actually constructed; and (B) preferred contour.

In passing it is interesting to examine the fluorescence pattern of Fig. 16, obtained by setting two jets each identical with that of Figure 14, directed at the horizontal centerline of the film, each about one-third of the way in from the sides of the frame. The two air streams interfere along a vertical line down the center of the frame, where the two airflow patterns come together to produce an area of low air velocity; cooling in this area is impeded. Since the "hot spot" is usually centered here, moreover, the jets perform even more unsatisfactorily because the hottest film areas get the least adequate cooling. It is found on actual projection of film that damage first occurs along the vertical centerline, confirming the fact that interference of the two air streams provides poor cooling there.

This fluorescent examination of air jets, therefore, produced one design — the venturi of Fig. 14 — that appeared considerably superior to the slit of Fig. 3. Having determined the apparent advantage of this design, this new jet was



Figs. 15–16. Phosphor patterns: cooling pattern of aerodynamic jet (Fig. 15), and cooling pattern of twin aerodynamic jets (Fig. 16).

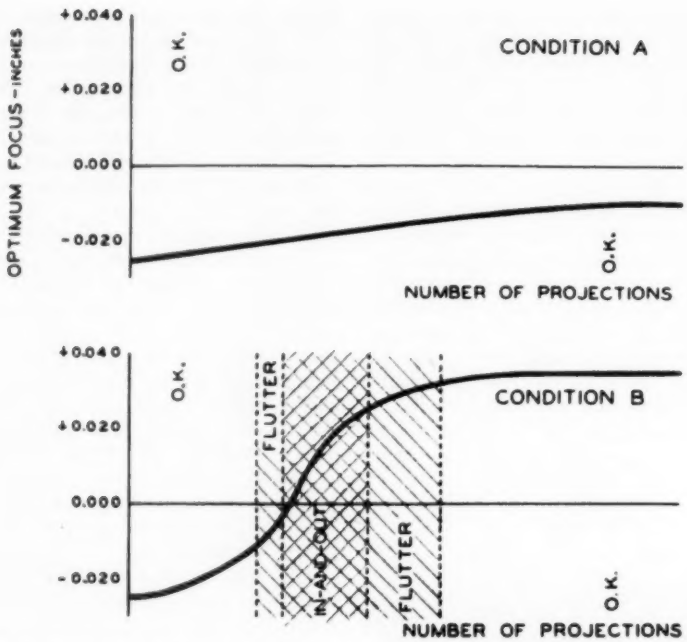


Fig. 17. Projection history of film as measured by changes in the point of best focus. If the point of best focus is determined for each projection of the film, the resulting curves can be related to film performance. This is particularly valuable for preliminary rapid testing to predict film behavior in the trade. A slow rate of change of focus, as in Condition A, is typical of good screen quality; a rapid rate of change of focus as in Condition B is always accompanied by poor image quality on the screen.

then compared with the older in a test with film itself, projected under normal conditions. This film comparison is the final evaluation of the screening done through the semiquantitative use of temperature-sensitive phosphors.

Confirmatory Film Testing

For the proper evaluation of projection apparatus by film testing, it is essential that the work be done with care, especially to insure that due account is taken of the severest possibilities and that the results can be interpreted practically without qualification.

Two procedures for the film evaluation of projection equipment have been described previously[1]: (1) the projection of experimental film, designed to provide permanent indication when its critical temperature has been exceeded, and (2) the projection of regular cine positive, under conditions where its focus changes with repeated projection and its variations in image quality can be determined.

For either of these tests to be meaningful, it is important that the film be freshly processed and that it not have been projected previously (such previous projection makes the film less critical and there is danger of an over-optimistic evaluation of the equipment). It is also necessary that the print include areas of adequate density, and that it be sharp

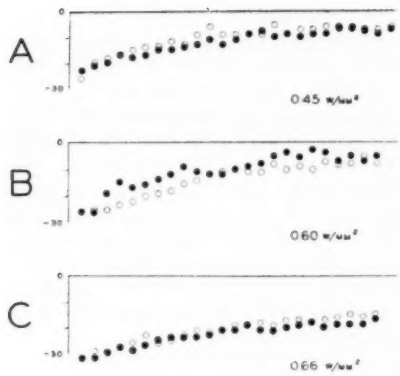


Fig. 18. Improvements in projection history of film with improvements in air cooling: (A) no air cooling; flux limited to 0.45 w/sq mm; (B) slit nozzle as in Fig. 5; flux limited to 0.60 w/sq mm; and (C) aerodynamic jet as in Fig. 15; flux limited to 0.66 w/sq mm.

and the action limited so that it will be possible to judge departures from ideal screen definition.

Comparison of nozzle designs by film testing was arranged to determine whether the venturi type (best of those tested by the phosphor technique) would maintain its advantage over the slit type (studied previously and found reasonably effective). In other words a comparison was made between the jet that gave the phosphor pattern of Fig. 15 and the jet that gave the phosphor pattern of Fig. 5.

When the experimental film procedure was applied to a study of these nozzles, the experimental film showed better performance with the jet of Fig. 14A. An increase in permissible flux densities of 5% to 10% over the limit for the slit nozzle was required before film cooled by the venturi jet reached its threshold temperature.

When the focus and image quality of normal cine positive — studied under critical conditions where changes in either factor can be measured carefully — were examined for evidence of differences between the two nozzles, a similar evaluation resulted. In this method of analyzing film behavior it has been shown that data like that of Fig. 17 are obtained, where Curve A represents good film behavior and satisfactory projection, Curve B poor film behavior and excessive projection conditions. This type of information obtained during loop projection tests of the two nozzles under test is shown in Fig. 18. It is apparent that the desirable curve shape A (cf. Fig. 17) can be otained with the slit jet for flux up to 0.60 w/sq mm, while with the venturi jet of Fig. 14-A, this same film behavior extends up to 0.66 w/sq mm — representing a 10% increase in effectiveness.

At the same time Fig. 18 shows that without air-cooling in this same equipment the limit is about 0.45 w/sq mm emphasizing the advantage gained from the cooling and positioning effects of air nozzles.

Recommendations

In this brief excursion into the proper design of jets for air-cooling, it has become apparent that the best design must take account of the equipment in which the jets are used. The most efficient design for one projector may be relatively inefficient for another in which the projector construction provides different air-flow paths, different opportunities for exhaust, etc. The outstanding advantage of the phosphor method of preliminary testing is that it makes the effects of such factors immediately visible. It is fortunately also relatively simple to apply, and therefore becomes a convenient tool for those designing projection equipment for maximum output.

Jet design to produce a symmetrical cooling pattern over the aperture area that complements the heating pattern has been shown to be a satisfactory design

criterion, and the relative performance of various jets seems to be pictured adequately by the phosphor-temperature patterns. Because the present semi-quantitative method does not show the level of cooling — except relatively — it is still necessary to examine the best design or the several best designs in actual film projection as final confirmation of their practical value.

From the work herein outlined it seems that the temperature-sensitive phosphors can be of real assistance in the design of projection equipment for increased screen illumination by illustrating graphically some of the design problems and shortening the engineering appraisal. It seems very likely that the method will prove equally advantageous for the engineering approach to other heat-transfer problems.

Conclusions

The temperature-sensitive phosphor method of determining temperature distribution has become a tool of great engineering use, especially when the circumstances permit a ready control of its variables. Applied to the design of air jets for cooling motion-picture film it makes visible much that would long be obscure, and it shortens the job of designing jets tailored to their environment. For those interested in obtaining maximum screen-light output for projection systems, this design method has much to offer.

Acknowledgments

The authors express their appreciation to C. J. Staud and C. R. Fordyce for continuing guidance from the very beginning of this problem, and to J. B. Hale for suggesting the method of solution. In addition many colleagues from the Eastman Kodak Co. have given great assistance — especially R. S. Battey and P. H. Preo who carried on the investigation of nozzle designs, D. R. Eastman who prepared the phosphor coatings, and N. R. Nail who assisted in devising suitable equipment.

References

1. F. J. Kolb, Jr., "Air cooling of motion picture film for higher screen illumination," *Jour. SMPE, 53:* 635–664, Dec. 1949.
2. N. R. Nail, D. Pearlman and F. Urbach, *Photoluminescence of Some Sulfide Phosphors as a Function of Intensity*, Cornell Symposium on Luminescent Materials. John Wiley and Sons, New York, 1946.
3. N. R. Nail, F. Urbach and D. Pearlman, "New observations on superlinear luminescence," *J. Opt. Soc. Am., 39:* 690–694, Aug. 1949.
4. F. Urbach, "Thermography," *Phot. J., 90B:* 109–114, July-Aug. 1950.
5. F. Urbach, N. R. Nail and D. Pearlman, "The observation of temperature distributions and of thermal radiation by means of nonlinear phosphors," *J. Opt. Soc. Am., 39:* 1011–1019, Dec. 1949.
6. F. Urbach, A. Urbach and M. Schwartz, "The brightness of apparent fluorescence as a function of the exciting intensities," *J. Opt. Soc. Am., 37:* 122, Feb. 1947.
7. U.S. Patent No. 2,551,650, May 8, 1951: "Measurement of Temperature Distribution on Surfaces of Solid Bodies."

Stereo X-Ray Motion Pictures

By S. A. WEINBERG, J. S. WATSON, R. GRAMIAK and G. H. RAMSEY

In stereoradiography, image displacement is obtained either by shifting the x-ray tube, or, less often, by keeping the tube stationary and rotating the subject through a few degrees of angle between exposures. Either of the methods can be applied to stereo cinefluorography, but the rotational method has the advantage of not requiring special x-ray equipment. A single-film projector having two picture apertures for stereo projection of rotational films is described.

Stereo pairs of x-ray films are generally exposed in sequence, the first from a "right-eye" position of the x-ray tube and the second from a "left-eye" position. The correct amount of tube shift (anode or target separation) is not necessarily equal to average interpupillary distance, but varies in relation to such factors as tube-to-film distance and subject thickness, the final criterion being the image displacement on the films. According to Klein, the stereo displacement of foreground image points should not exceed about 8.5 mm if the films are to be viewed at reading distance.[1]

This matter of anode separation has been one of the major problems in experimental work on three-dimensional x-ray motion pictures. Since it would obviously be impractical to shuttle an x-ray tube back and forth at motion-picture frequencies, the tentative solution of the problem has been to use not one but two x-ray tubes, energized alternately, or, as in Janker's early apparatus, continuously, with a revolving lead shutter to interrupt first one x-ray beam and then the other.[2] Meanwhile the motion picture camera copies the alternate right- and left-eye images as they appear successively on the fluorescent screen of the cinefluorographic unit.

Unfortunately the x-ray tubes suitable for motion-picture work are of such large diameter that their anodes cannot be brought much closer together than 15 cm. This is entirely too big a separation for average cinefluorography and can only be used with small, easily penetrable subjects at unusually long target-to-screen distances. It is true that in making full-scale stereo chest films the tube is sometimes shifted as much as 15 cm. But films of this sort are made with the tube 180 cm from the films and

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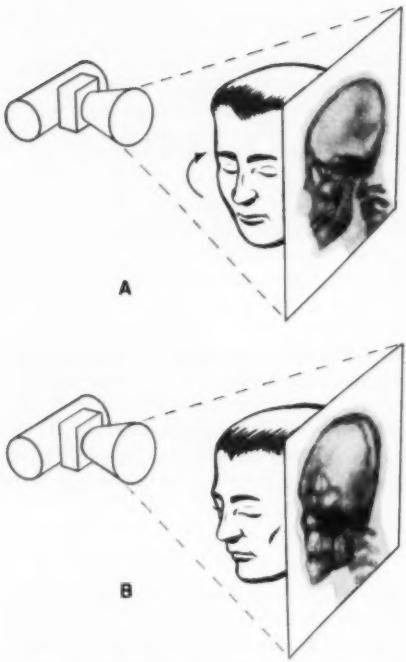

Fig. 1. Radiation from the x-ray tube (left) produces image of the subject on the film (or fluorescent screen). The first view is made with the subject in position A, the second in position B. The two views make up a stereo pair.

are viewed at 90 cm on a Wheatstone stereoscope. Furthermore, if there is eyestrain involved in fusing the images, the radiologist accepts it on the theory that eyestrain is indispensable to the localization of small details in depth. With stereo motion pictures, on the other hand, which are made at an average target-to-screen distance of 75 cm and viewed by projection, anode separations of more than a very few centimeters generally mean that the images cannot be fused at all.

What is probably needed here is a special x-ray tube with two separate anodes or focal spots capable of being energized alternately so as to produce first a right and then a left x-ray beam. Failing the special tube, something might be done with a pair of high-voltage sources at a distance from the screen of several meters. But if neither the special tube nor the high-voltage sources are forthcoming, the only course that remains is to abandon anode separation for a different principle.

Rotational Stereo

That rotational procedures are an aid toward seeing things in the round and in depth is a commonplace of routine x-ray work although such procedures are not necessarily stereoscopic methods. One of the most reliable ways of locating foreign bodies, for example, is to make two views at right angles, and this is done by rotating the subject 90° between exposures. Body section radiography, too, depends on rotational movements of the tube and film around the subject, while in fluoroscopy depth relations are most easily established by turning or rolling the subject from side to side.

What is not so generally known is the fact that subject rotation can be substituted for tube shift to make true stereo pairs of films. An ingenious apparatus for holding and turning (or inclining) the subject through a few degrees of angle between exposures has recently been described by Gordon and Sauro.[3] The location in depth of the axis around which rotation takes place apparently makes little difference to the ultimate stereo effect, since in x-ray work there is no perceptible horizon or background beyond the far edge of the subject's body.

It will be noticed that in the procedure just mentioned the exposures are made with the subject at rest, and that there is ample time for rotating the subject from position A (see Fig. 1) to position B. This starting and stopping of rotation is, of course, not practical at motion-picture frequencies. In motion-picture work the subject is therefore made to rotate

continuously. The first motion-picture exposure "arrests" the subject in what corresponds to position A, the second exposure in position B, the third in position C, etc. The stereo "pairs" of frames, which will appear simultaneously on the projection screen, may consist of frames one and two, two and three, three and four, etc., or, if greater image displacement is desired, of frames one and three, two and four, three and five, etc.

So far as our own work in this field is concerned, it must be confessed that we came upon the rotational principle largely by accident and that we were not then aware of Janker's previous experiments, which included not only rotation of the subject in front of the tube, but rotation of the tube in an arc around the subject. We were attempting, at the time, to verify our theoretical anode separation figures by making stop-motion films of a skull at a target-to-screen distance of 75 cm. The stop-motion technique, of course, had the advantage of permitting the tube to be shifted back and forth by hand between exposures. The skull (an anatomical specimen) was mounted on an indexed turntable and was rotated 2 degrees for each stereo pair of negative frames. In all, 180 stereo pairs of frames were photographed, so that the skull made a complete revolution. The resulting right-eye frames were printed successively on one length of positive film, and the left-eye frames on another. The two prints were then made into continuous loops and run together on a stereo motion-picture projector.

As it turned out, the scenes which gave the best stereo illusion were those made with a tube shift of 2 cm. However, all of the skull scenes "stereoed" so much better than some other experimental scenes made with nonrotational types of stop motion that we began to wonder whether rotation alone without tube shift might not give a binocular stereo effect. We therefore projected two identical right-eye prints of the revolving skull, threading one of the prints in the projector in such a way that it led the other by one frame. Later we tried putting the prints out of step by two, three, and four frames and projecting them at different speeds. Some differences in ease of fusion were observed, but the fact remained that the stereo effect of the revolving views made with a single position of the tube was fully as good as that of the views made with tube shift.

The next step was to try out the rotational stereo method with living subjects at motion-picture speeds. The subject was placed in front of the fluorescent screen and rotated steadily through one complete revolution. Films were made in this way of the chest, the head and neck, the knee and ankle joints, and the hand and wrist. Scenes of this kind are quite effective when simply run through a standard, single-film projector. Within the chest, for instance, the constantly changing silhouette of the heart and slope of the diaphragm can be followed without too much difficulty, provided the observer has enough anatomical knowledge to orient him. But when the scene is run on the stereo projector, the boundaries and depth relationships of the structures are clear even to the least experienced.

Practical Difficulties

Both anode separation and rotational stereo cinefluorography suffer from the fact that their stereo "pairs" of frames cannot be exposed simultaneously, as in conventional stereo motion pictures, but must be exposed in sequence. With live subjects this means that there is often movement (other than stereo displacement) between one frame of the pair and the other. So long as the movement is horizontal the discrepancy is hardly noticed at all, but if a rapid vertical movement occurs, the local failure of the stereo illusion is quite disconcerting. Thus, when a swallow of a barium mixture progresses rapidly down the

esophagus, its leading edge will be a focus of distraction all the way to the cardia (upper orifice of the stomach). Because of the usually greater time interval between its stereo pairs of frames, the rotational method is apt to be more seriously afflicted with this trouble than the anode separation method.

Another obvious source of dissatisfaction with rotational films is the constant turning round of the subject, which goes on relentlessly whether it is wanted or not. Important details are seen fleetingly and tantalize the spectator like girls on a merry-go-round. We need not carry the simile further except to note that, if rotation stops, the glamorous stereo illusion vanishes, and only reappears when rotation begins again.

Fig. 2. Typical setup for barium swallow study of esophagus. Patient on mechanized chair has turned 180° during 10-sec exposure. Rate of rotation can be varied for different camera speeds.

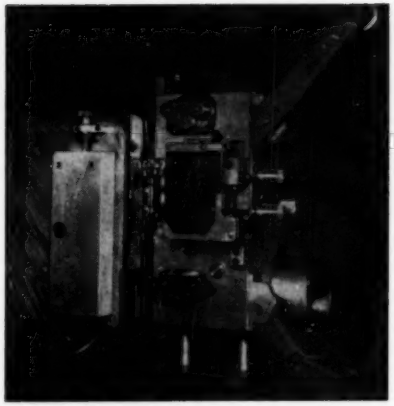

Fig. 3. Complete projector. First surface mirrors (behind Polaroid filter) are mounted 45° to film plane. Projection screen is at right angle to film plane.

Attempts to minimize the rotational element (while still retaining the stereo illusion) have been only moderately successful. It is not necessary, of course, to rotate the subject through the full 360°; in fact it is sometimes impossible. Angiocardiographic subjects,* for example, are encumbered with splints and tubing and can only be rotated through a limited angle. In cases of this sort the image displacement of the stereo pairs can be increased by moving the tube through an arc of 30° or 40° in a direction counter to the rotation of the subject, or, in still more extreme cases, the subject can be kept stationary and the tube alone moved. Unfortunately any departure from frank rotation tends to immobilize the structures which lie nearest the fluorescent screen in the background of the image. This in turn decreases the stereo displacement of the background elements and may weaken the stereoscopic illusion.

It should be noted that in the stereo pairs of frames made by the rotational

* Radiographic visualization of the chambers and vessels of the heart by injecting a radio-opaque dye into the bloodstream.

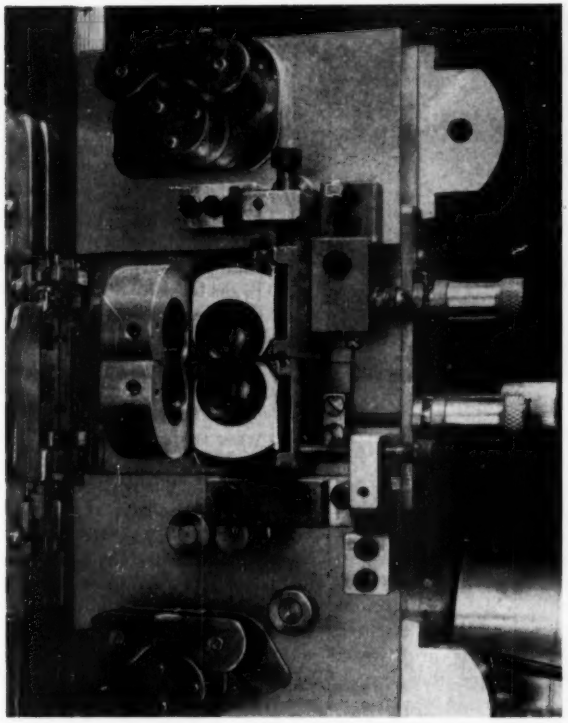

Fig. 4. Twin-aperture plate, matched lenses and first surface mirrors. Knurled extension on right are focus and threading adjustments. Top mirror rotates on horizontal axis, bottom mirror on vertical axis.

method the displacements of the foreground image elements, which lie in front of the center of rotation, take place not as in conventional stereo, against a background of increasingly static elements, but against a background of elements which are displaced in the opposite direction. Thus it can be said that the displacements which contribute to the stereo illusion are reinforced by the rotational method to the extent of being almost doubled. This "overdetermination" is helpful in the case of cinefluorographic scenes of thick subjects, which, for reasons mentioned in a previous paper, are often too unsharp for stereo treatment by the anode separation method.[4]

Apparatus

For exposing rotational films, no special x-ray equipment is needed, nor do there have to be any changes in the cinefluorographic unit. The motor-driven, revolving chair shown in Fig. 2 makes a good turntable for rotating the average subject, while, with subjects who can be rotated only a little or not at all, the tube is moved along a semicircular track through an arc of 20° with the x-ray beam centered on the fluorescent screen.

For projecting the films, the conven-

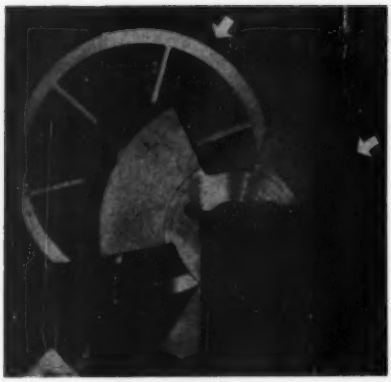

Fig. 5. Skeleton shutter which replaces original shutter. New shutter mounted below twin apertures.

tional twin stereo projector is satisfactory within its limitations, but it takes a long time to thread, is twice as liable to film breakage as a single-film projector, and has other faults which are only too well known to projectionists. Furthermore its two film channels are wasted on rotational films, since the prints from rotational negatives are not true right- and left-eye prints, and are only transformed into stereo pairs by "staggered" projection, which could be accomplished just as well in a single projector having two picture apertures.

While still working with the twin stereo projector we had found that the best stereo displacement for average subjects was obtained by simultaneous projection of frames one and three, two and four, three and five, etc. The special 16mm projector was accordingly designed with two picture apertures located vertically one above the other and separated by a distance between their center lines of 0.600 in. minus 0.003 in. to allow for film shrinkage. The film movement was borrowed from a Kodak Pageant projector, the standard film gate being replaced with a longer one to accommodate the two apertures (Fig. 3). Because of the close proximity of the picture axes, illumination was managed with a single lamp and condenser system. This expedient kept the size of the projector within usual 16mm limits, though at some expense of screen brightness. The lamp was made adjustable horizontally and the condenser vertically to take care of variations in lamp bases. To obtain stereoscopic effect, polarizing filters are placed over each of the two projector lenses and the projected image is viewed through polarizing spectacles.

The rest of the optical system consisted of two projection lenses, one for each aperture (Fig. 4). These had to be of relatively small diameter if their axes were to be brought within 0.597 in. of each other. A matched pair of Eastman Kodak "eyepiece components" was selected having focal lengths of 25 mm and apertures of $f/1.9$. The diameters of the lens barrels were further reduced locally by grinding flat areas along the adjacent sides to within a few thousandths of the edges of the glass elements, thus permitting the correct axis separation. The finished assembly has vernier focusing adjustments and the lenses can be moved separately or as a unit.

If we had had patience enough to modify the lenses further to bring their central axes to within 0.581 in. of each other this would have given us the proper vertical image alignment on the screen. However, to do this would have necessitated breaking through the lens barrel and grinding flats on the elements as well. A preliminary test showed that vertical alignment and horizontal adjustment could be managed by using first surface mirrors immediately in front of each lens and at 45° to the optical axes. One mirror is mounted on a vertical axis and the other on a horizontal axis. Considering that the images are projected parallel to each other, the vertical disparity on the screen is never more than the 1.5-cm lens separation. Consequently the slight rotation of the image (the roof prism effect of the mirror

moving on the horizontal axis) is not enough to introduce any noticeable conflict.

In order to ensure uniform occultation of the two picture apertures, the original shutter (which also served as a drive pulley) was replaced with a skeleton shutter (Fig. 5), and a three-bladed shutter of 4-in. diameter was installed on a new shutter shaft located a little beneath the lower picture aperture. With this arrangement the periodic difference of illumination between the two pictures is so minute as to be negligible.

References

1. Edw. Klein, Milton Klein, Harold Klein and Albert T. Newman, "An investigation of some practical aspects of roentgen ray stereoptics," *Am. J. Roentgenol., 49:* 682–690, May 1943.
2. Robert Janker, "Zur Frage der Röntgenstereoscopie," *Fortschr. an dem Gebiete der Röntgenstr. 71:* 339–344, 1949.
3. Elias Gordon and Joseph Sauro, "A new method of stereoscopic roentgenography," *Am. J. Roentgenol. 70:* 824, Nov. 1953.
4. S. A. Weinberg, J. S. Watson and G. H. Ramsey, "X-ray motion picture techniques employed in medical diagnosis and research," *Jour. SMPTE, 59:* 300–308, Oct. 1952.

Errata

J. D. Bick, "Methods of Measuring Surface Induction of Magnetic Tape," *Jour. SMPTE, 60:* 516–525, Apr. Pt. II, 1953.

The following confusion of terminology with respect to this paper has been brought to light.

Surface induction as defined by NARTB is "the flux density (B) at right angles to the surface of the tape." A recording having constant flux vs. frequency at the surface of the tape will have a surface induction which is proportional to frequency. The open circuit voltage output of an "ideal" short gap head is proportional to the rate of change of flux, or in other words proportional to frequency. Therefore, the open circuit voltage of the "ideal" short gap head is proportional to surface induction. What this means regarding the article is that all curves labelled "surface induction" and discussions of those curves show an error of 6 db/octave. The article would be correct if the words "surface flux" were inserted everywhere "surface induction" appears.

An error of a similar nature appears in one portion of the NARTB Recording and Reproducing Standards of June 1953 and the proposed standard of the CCIR (Doc. 789-E, 4 October 1953). This error is being acted upon by the respective bodies and will be corrected in the near future.

Committees of the Society as of March 16, 1954, Administrative Committees, *Jour. SMPTE, 62:* 327, Apr. Pt. I, 1954.

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Pneumatic Pulldown 16mm Projector

By RAYMOND W. WENGEL

An experimental model of a 16mm projector is described in which air pressure is used to effect pulldown of the film. Some results of speed tests for this type of pulldown are discussed.

THE PNEUMATIC PULLDOWN is a device for advancing the film in the gate of a motion-picture apparatus by the direct application of air pressure to the film. At the Eastman Kodak Co. several pulldowns of various constructions, but all answering to this description, have recently been under experimental development.

One of them was carried to the point of a trial application in a pushbutton-operated repeater projector. This was installed in the George Eastman House of Photography at Rochester, N.Y., for test. The results attained in this work are of a preliminary character but are thought to be of sufficient interest to warrant presentation at this time in view of the current interest in rapid-acting pulldowns, and because there does not appear to have been a previous discussion of similar devices in the annals of the Society.

The mechanisms commonly employed for intermittently advancing the film in cameras and projectors are either reciprocating, as in the claw pulldown, or intermittently rotating as in the Geneva-driven sprocket. In both cases the effective masses of the moving parts often are much greater than the mass of the film to be moved so that to avoid vibration and noise the parts must be nicely fitted and substantially mounted.

Although these mechanical systems have been highly perfected and for the most part function satisfactorily under ordinary conditions, they become more difficult to design and make as the required speed of operation increases. A logical compulsion has thus arisen to attempt radical modifications of these devices or to find a new concept of the pulldown which would not carry with it the handicaps of large mass and precision manufacture.

The use of controlled air pressure acting directly on the loops of film adjacent to the gate to advance the film successfully removes the need for intermittently moving solid parts. In addition, by furnishing a convenient means for retaining the film under tension in the gate, air pressure permits the use of a fixed locating pin to engage the

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(This paper was received on March 24, 1954.)

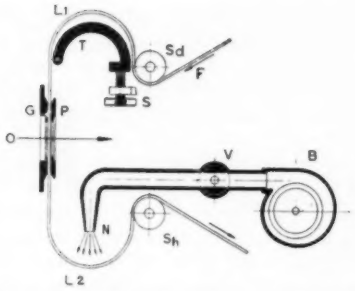


Fig. 1. Simplified air-pulldown principle.

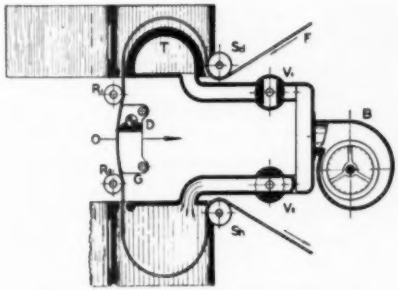


Fig. 2. Experimental air pulldown.

perforation so that a superior vertical steadiness results. Furthermore, if a curved gate is used, the pressure plate ordinarily required to hold the film stationary during the projection phase may be eliminated. In the latter case, there is practically complete relief from the evils that sometimes arise when film is moved between squeezing surfaces.

Before entering into a discussion of the Eastman House projector, it is perhaps desirable first to give some consideration to the principle of the air pulldown itself. Figure 1, the simplest case as well as one of historical interest, shows the bare elements of a pneumatic pulldown. This is substantially the same as the arrangement shown in a U.S. patent issued some 35 years ago to H. F. Evans of England. In this simplified representation S_d and S_h are the usual driving and holding sprockets respectively, L_1 and L_2 the upper and lower loops, G the gate and P the pressure pad. O is the optical axis. In place of a claw or Geneva sprocket, however, there is the nozzle N, rotary valve V and the blower B. The operation of the pulldown may be thought of as starting with the opening of valve V so that air passes through to the nozzle and thence is directed onto the lower loop. The tension thus created in the film of the lower loop overcomes the gate friction, and the film moves downward until the upper loop is pulled into contact with the limiting track T. Thereupon, the valve closes, shutting off the air to the lower loop and relieving the film tension. The gate friction then holds the film stationary while the new frame is projected. During this interval the upper sprocket feeds another frame length into the upper loop preparatory to the next pulldown stroke. Framing is accomplished by adjustment of the screw S which raises or lowers the track T. This changes the length of film included between the acting tooth of sprocket S_d and the gate at the moment the pulldown is completed. Unfortunately, a machine built strictly according to this diagram would not be satisfactory in operation and would fail to give the possible advantages of the pneumatic pulldown. For one thing, the vertical steadiness would be poor because the registering point is a tooth of the sprocket too remote from the gate. Also, the drag due to gate friction would seriously interfere with the attainment of a high speed of pulldown.

An independently conceived and different construction of the pneumatic pulldown is shown diagrammatically in Fig. 2. Here, in addition to the air supply to the lower loop, there is a similar supply to the upper loop under control of an upper valve V_1. The limiting track T remains as before, but is now of open construction so that air may pass through and push against the upper loop. To make efficient use of the air, side plates are provided to reduce

leakage. The outer side plates are shown mounted on hinges and swung open as though for threading. The gate is represented by G and is curved concave towards the lens. It is fitted with rollers R_1 and R_2 to help keep the film in contact with the surface and with a fixed detent D having a sloping face upstream of the film and a radical face downstream. The detent thus engages the perforation in the manner of a ratchet pawl so that upward motion is prevented but downward motion is not impeded. So a downward pull on the film will cause it to be advanced in the gate, and an upward pull will cause it to be held in register against the detent. By positioning the detent suitably with respect to the gate aperture, it serves also as a locating pin to register the frame.

The operation of this pulldown system can now be followed easily. Supposing the bottom valve V_2 to be open, air flows into the lower loop, rapidly building up pressure therein and causing an expansion of the loop which draws the film downward in the gate. The motion is limited, as before, by the curved track T, but in this case the setting of the track and drive sprocket allows a slight overtravel to insure that the new perforation falls over the detent with some extra space between its lower edge and the bottom surface of the detent. Continued rotation of the valve V_2 causes it to shut off the air to the lower loop at this moment, but, at the same time, valve V_1 is opening and letting air flow into the upper loop. Now the upper loop tends to expand and give a retrograde motion to the film. Movement in this reverse direction, of course, is brought to an end when the lower edge of the perforation comes into contact with the detent D, thus locating the new frame in the gate. Air pressure is maintained in the upper loop during the projection period in order to keep the film tight against the detent. The air pressure in the lower loop is in the meantime rapidly falling by reason of the leakage through perforations and past the edges of the film. Even so, the residual pressure serves to maintain sufficient tension in the film below the detent to hold it in contact with the gate surface and keep the picture in focus. At the end of the stationary period the upper valve closes and the pressure in the upper loop is dissipated by leakage while the lower valve again opens allowing air to rush into the lower loop to initiate the next pulldown stroke. The successful operation of the system requires that the valves have the proper timing relative to the sprockets, and measure out the right proportion of air to each loop. The leakage rates at the loops also must be set at suitable values. None of these factors, however, is of a critical nature, and it is, therefore, possible with ordinary quality of manufacture to have a smoothly running machine. The use of the fixed detent at the aperture insures a high degree of vertical steadiness.

The two loops of this pulldown might bear comparison to the pistons of a gas engine. In operation, the sound produced is even more strikingly suggestive of a gas engine. Fortunately, this sound, which originates in the sudden discharge of air into the loops, is but feebly coupled to the solid structures of the machine and can be almost entirely done away with by a simple acoustical case.

The opportunity to apply the pneumatic pulldown came about through the need for reliable repeating projectors in the George Eastman House of Photography in Rochester. The chief requirements in the application were to extend the period between necessary servicing stops and to increase greatly the useful life of the film.

The pneumatic principle, it was thought, would contribute to the life of the film in projection because the absence of a pressure pad greatly reduces friction in the gate, and, therefore, the force acting on the perforation edge

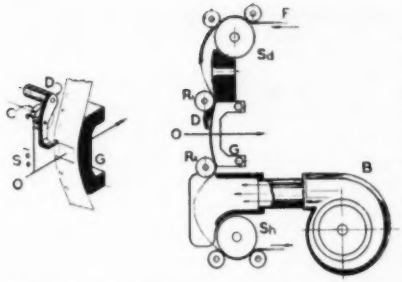


Fig. 3. Air-pulldown mechanism of repeater projector.

during pulldown is significantly less. For the same reason, there is much less chance of the film sticking in the gate and consequent failure of the pulldown.

The pneumatic pulldown selected for this application differs from that just described and is shown diagrammatically in Fig. 3. It was felt that the fixed detent in the gate of the previous example would, after many round trips of the film, have a tendency to tear the top edges of the perforations as they slid down the sloping surface. To avoid this, the fixed detent was replaced in the new form by the cam-operated movable detent shown at D. Advantage was taken of this change also to get rid of the bulky rotary air valves. It was no longer necessary to have air pressure in the upper loop to keep the perforation edge against the detent. Instead, a constant pressure in the lower loop could be used, both to hold the edge against the detent and effect the pulldown when the detent is withdrawn from the perforation. As before, the gate is curved and a limiting track is used to control the amount of film displaced. The loops themselves are more flattened than those shown before. This secures an advantageous bow string action.

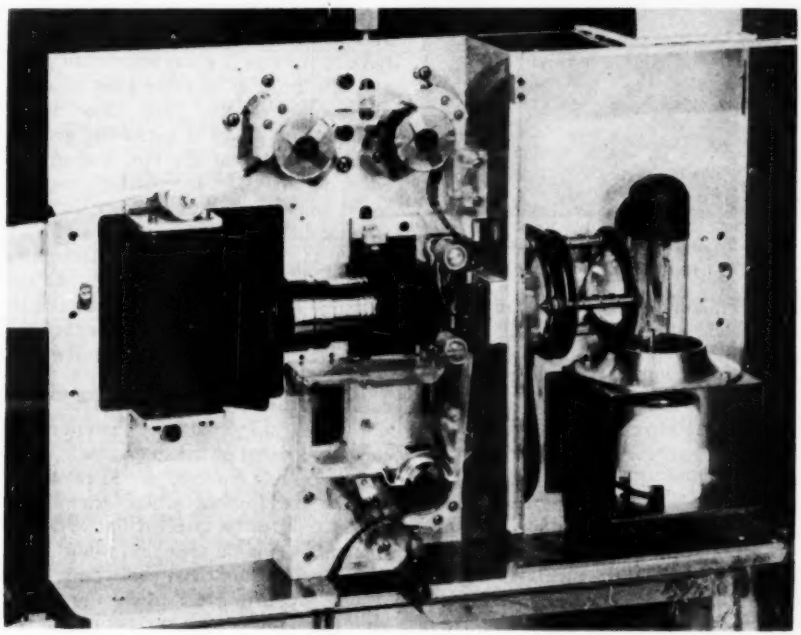


Fig. 4. Repeater projector mechanism.

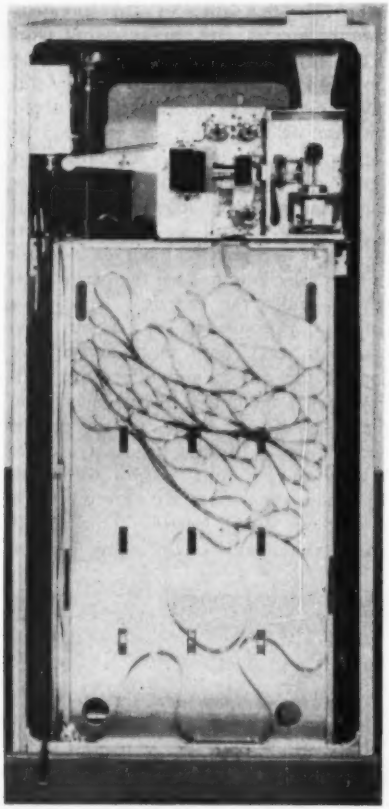


Fig. 5. Endless-loop film magazine.

For example, just before the detent is withdrawn, the lower sprocket has fed all except about a half frame out of the lower loop so that this loop is nearly flat. As a result, the film tension is considerably increased, a greater force is developed to overcome gate friction, and a greater initial acceleration occurs than would result with the semicircular loops. Similarly, the upper loop flattens as the pulldown stroke nears the end and this, together with the reaction of trapped air between the loop and fixed track, helps to decelerate the film. Control of the cushioning effect is afforded by proper sizing of the hole leading through the fixed track from under the loop to the outside.

The movable detent D is of such small size and mass that only a relatively small pressure of the spring S is needed to make it follow the cam C. For this reason, the point of the detent does not damage the film if at any time it should fail to enter the perforation and instead rub against the moving film. Test runs have shown consistently that film life with or without the detent in operation is the same.

Figure 4 is from a photograph of this projector showing the pulldown mechanism. Figure 5 shows the projector mounted in the cabinet. Space does not permit a description of all the auxiliary devices associated with this machine but it may be of interest to consider the continuous loop film magazine seen just beneath the projector in Fig. 5.

The magazine is a tall, thin, rectangular box holding film looped back and forth in a random manner. The back of the box is a flat aluminum plate and the front is of plate glass to allow observation of the film. The space between the plates is somewhat greater than the width of the film and at the edges is closed in by narrow strips of wood undercut in their inner faces to avoid contact with the picture area. A gap in the top permits entry of the film as it comes from the projector. At the lefthand bottom corner is a similar gap fitted with a roller underneath which the film passes to the vertical channel and then back to the projector.

The feature of interest is that the loops of film are supported by a current of air flowing upward in the magazine. Were it not for this current, the loops would fall to the bottom where the lowest would tend to be crushed flat and permanently creased. The film would then, of course, be unfit for projection.

The supporting air enters the magazine through holes at the bottom of the back plate and flows upward through the

mass of loops to exhaust ports near the top. These are the two uppermost elongated slots in the back plate. A counter current of air flows downward from the top toward the exhaust ports and is of value in that it assists in spreading out the loops as they are formed. Control of the air flow to suit the quantity of film in the magazine is effected by a manual valve in the air line to the bottom holes and by an adjustable bypass in the vacuum line to the exhaust ports. It happens that in the illustration the air flow is excessive and has caused the loops to ride too high in the magazine. The difference in pressure required from bottom to top ranges from 0.1 in., water gauge, for shorter lengths, as for instance 100 ft, to 1-in. pressure for a full capacity of 400 ft. As an additional precaution against loading of the outgoing film by loops that might otherwise press upon it, there are three curved spring fingers reaching through the rectangular slots, seen just above the bottom air holes. These lightly interfere with the film loops at this level. In effect, the fingers form a false bottom to the magazine beneath which the film is free to be drawn out by the projector. Similarly, when the machine is stopped and air flow is no longer present to support the film, retractable soft rubber pads, seen in the remaining six rectangular slots, are pressed forward to securely clamp the film loops against falling to the bottom.

This experimental combination of pneumatic pulldown projector and pneumatic film magazine has proven to be more satisfactory than the commercially available equipment in use at the Eastman House. The first trial, over a period of several months, resulted in 1834 runs of a single 200-ft length before cracking at the corners of the perforations brought an end to the test. Other test runs made over a shorter period of time and with the projector running continuously gave an average of more than double this figure. It is believed that a useful life of 5000 runs will be attained when certain improvements are made in the projector.

It was indicated earlier that the pneumatic pulldown should be capable of high-speed operation. Referring again for the moment to the two-valve type shown in Fig. 2, it is clear that the air pressure in the lower loop is the main factor determining the speed. For example, a 90° pulldown for 16mm film requires only a moderate pressure of 3–4 in. water gauge. The maximum usable pressure was found to be 14 in. or about one-half pound per square inch. Above this pressure the edges of the perforations engaging the sprocket teeth would buckle. The speed attained with this pressure corresponded to a pulldown angle of 15° at 24 frames/sec, or a time of 1.7 msec. As a matter of curiosity, pictures were projected with this speed of pulldown but without a shutter. It was interesting to note that only scenes containing horizontal boundaries of high contrast were marred by a faint but objectionable ghost image due to the frame in its lowest position before it was pulled upward into register against the detent.

To raise the working pressure further it was found necessary to clamp the film at the sprockets in some manner that would distribute the force throughout the cross section instead of concentrating it at the perforation edge. To simplify the apparatus for initial trial a film strip was merely clamped at the ends, allowing about $1\frac{1}{2}$ frames slack to form the upper and lower loops. A moderate, constant air pressure was applied to the upper loop to draw the film back to its initial position after each pulldown stroke. In this way, the same piece of film could be repeatedly pulled down at speeds dependent upon the pressure applied to the lower loop.

At 4 psi the film withstood more than 300,000 successive pulldowns without breaking, and the stroke time measured 0.8 msec. The ultimate for this setup was reached with 7 psi. At this pressure

the film strips would on an average last for 1,000 successive pulldowns. The duration of the pulldown stroke was 0.5 msec.

The experimental work done with the air pulldown indicates that it may find a place in the design of future motion-picture apparatus. A greater force may be applied to the film with relative ease by air pressure to effect a shorter time of pulldown or to increase the length of pulldown stroke. Air pressure maintained in the upper or lower loop can conveniently be used to keep the film under tension in the gate and held against a registering pin so that the pressure plate friction can be reduced or eliminated altogether, and a high degree of vertical steadiness results. The experimental operation of the cabinet projector described above gives evidence that the air pulldown would be desirable in automatic or pushbutton-operated projector systems because it is easier on the film, and loss of loop, if it occurs, is only momentary and rarely results in damage to the film. Although other possible applications have not as yet been worked out in detail, there would seem to be many places in which the air pulldown might be a satisfactory element of design.

American Standards

PH22.2, -.3, -.17, -.36, -.94 — 1954

Five American Standards approved by the American Standards Association on April 5 1954, are published on the following pages. The first four are revisions of previous standards, while the last one is new. These five standards were published previously for trial and comment and the background information on their development and processing will be found in the May 1953 *Journal* for PH22.2 and -.3 in the June 1953 *Journal* for -.17 and -.36, and September 1953 *Journal* for -.94 — *Henry Kogel*

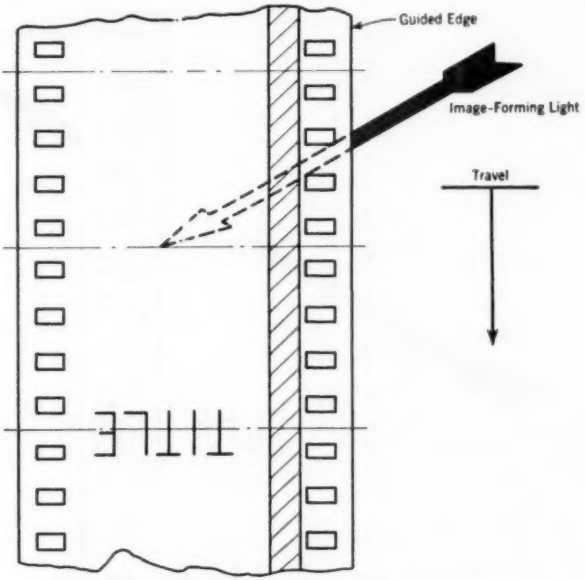
American Standard

35mm Sound Motion-Picture Film Usage in Camera

ASA
Reg. U.S. Pat. Office

PH22.2-1954
Revision of Z22.2-1946

*UDC 778.5



Drawing shows film as seen from inside the camera looking toward the camera lens.

1. Position of the Emulsion

1.1 Except for special processes, the emulsion shall be toward the camera lens.

2. Rate of Exposure

2.1 The rate of exposure shall be 24 frames per second.

3. Relationship Between Sound and Picture

3.1 The apparatus and film shall be so arranged that the sound is placed on the film 20 frames, ± ½ frame, ahead of the horizontal centerline through the corresponding picture. Thus, a given point on the film shall pass the soundhead after it has passed the picture aperture.

Approved April 5, 1954, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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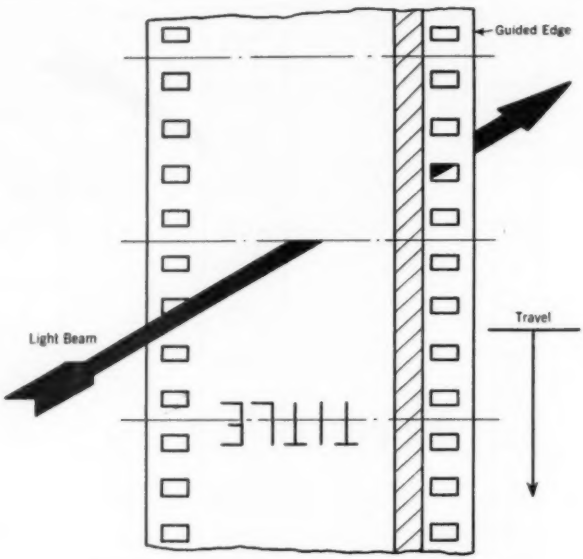
ASA3(M554

Price, 25 Cents

American Standard

35mm Sound Motion-Picture Film Usage in Projector

ASA
Reg. U.S. Pat. Office
PH22.3-1954
Revision of Z22.3-1946
*UDC 778.5



Drawing shows film as seen from the light source in the projector.

1. Position of the Emulsion

1.1 Except for special processes, the emulsion shall be toward the light source of the projector.

2. Rate of Projection

2.1 The rate of projection shall be 24 frames per second.

3. Relationship Between Sound and Picture

3.1 The apparatus and the film shall be so arranged that when the film is threaded normally, the soundtrack is scanned for reproduction at a point 20 frames, ± ½ frame, ahead of the centerline through the picture being projected. Thus, a given point on the film shall pass the soundhead after it has passed the picture aperture.

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ASA35MS54

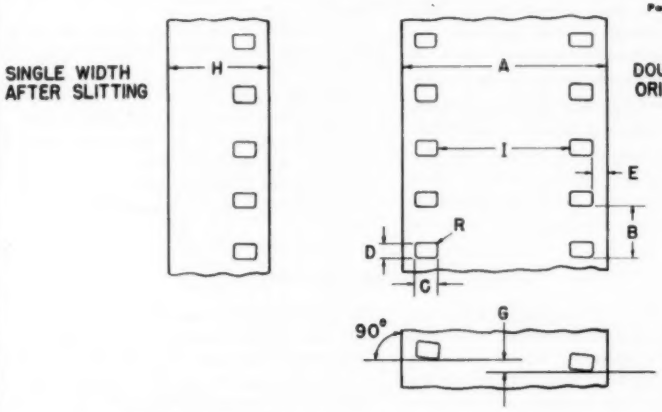
Price, 25 Cents

American Standard

Dimensions for 8mm Motion-Picture Film

ASA
Reg. U.S. Pat. Office
PH22.17-1954
Revision of Z22.17-1947

*UDC 778.5.771.5



Dimensions	Inches	Millimeters
*A	0.629 ± 0.001	15.98 ± 0.03
†B	0.150 ± 0.0005	3.810 ± 0.013
C	0.072 ± 0.0004	1.83 ± 0.01
D	0.050 ± 0.0004	1.27 ± 0.01
*E	0.036 ± 0.002	0.91 ± 0.05
G	Not > 0.001	Not > 0.025
H	0.314 ± 0.002	7.98 ± 0.04
I	0.413 ± 0.001	10.490 ± 0.025
‡L	15.000 ± 0.015	381.00 ± 0.38
R	0.010	0.25

These dimensions apply to negative and positive raw stock immediately after cutting and perforating.

* For low-shrink film as defined in Appendix 2, A shall be 0.628 ± 0.001 and E shall be 0.0355 ± 0.0020.

† In any group of four consecutive perforations, the maximum difference of pitch shall not exceed 0.001 inch and should be as much smaller as possible.

‡ This dimension represents the length of any 100 consecutive perforation intervals.

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ASA(M55)

Price, 25 Cents

(These Appendixes are not a part of the foregoing Standard.)

Appendix 1. Uniformity of Perforations

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the roll.

The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important. This is one of the reasons for the method of specifying uniformity in dimension B.

Appendix 2. Shrinkage Characteristics

In the early days of 16mm film the safety base used for this film had the characteristic of shrinking very rapidly to a certain fairly definite amount and then not shrinking much more. Although this film tended to swell at high humidities, nevertheless the shrinkage that occurred in the package before the user received the film was always at least as great as any swell that might occur due to high humidities at the time of use. This meant that the user never encountered film, even at high humidities, that had greater width than that specified in the standards. This meant that camera and projector manufacturers seldom ran into trouble so long as their film gates would readily pass film at the upper limit of the slitting tolerances, namely 0.630 inch.

Within the past few years, however, a safety base with lower shrinkage characteristics began to be used. Although this film was less susceptible than the previous film to swelling at high humidities, nevertheless the shrinkage characteristics were low enough so that this shrinkage did not always compensate for the swell at high humidities. For this reason film slit at the mid point of the tolerance for width, namely 0.629 inch, would occasionally swell at high humidities to such an extent that it would bind in film gates designed to pass film with the width of 0.630 inch. The manufacturers, therefore, were compelled to slit at the lower edge of the tolerance permitted by the American Standard. Variations in their slitting width, however, sometimes produced film slit below the limits of the standard.

For this reason an alternate standard has been adopted for this low-shrink film in order that the manufacturers may slit within the standard and still produce film which does not exceed 0.630 inch even at high humidities.

For the purpose of this specification, low-shrink film base is film base which, when coated with emulsion and any other normal coating treatment, perforated, kept in the manufacturer's sealed container for 6 months, exposed, processed, and stored exposed to air not to exceed 30 days at 65 F to 75 F and 50 to 60% relative humidity and measured under like conditions of temperature and humidity, shall have shrunk not more than 0.2% from its original dimension at the time of perforating.

This definition of low-shrink film is to be used as a guide to film manufacturers, and departure therefrom shall not be cause for rejection of the film.

PH22.17-1954

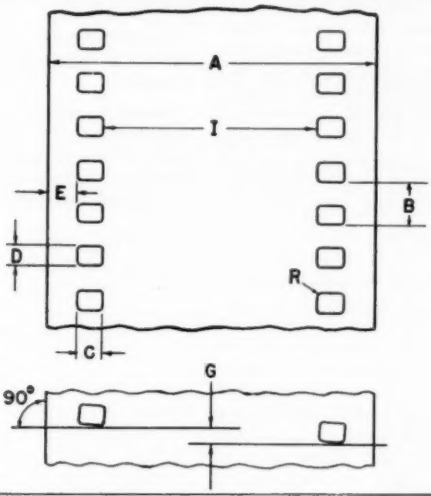
American Standard

Dimensions for 35mm Motion-Picture Positive Raw Stock

ASA
Reg. U.S. Pat. Office

PH22.36-1954
Revision of Z22.36-1947

*UDC 778.5.771.5



Dimensions	Inches	Millimeters
A	1.377 ± 0.001	34.98 ± 0.03
B	0.1870 ± 0.0005	4.750 ± 0.013
C	0.1100 ± 0.0004	2.794 ± 0.01
D	0.0780 ± 0.0004	1.98 ± 0.01
E	0.079 ± 0.002	2.01 ± 0.05
*G	Not > 0.001	Not > 0.025
I	0.999 ± 0.002	25.37 ± 0.05
†L	18.70 ± 0.015	474.98 ± 0.38
R	0.020	0.51

These dimensions apply to the film immediately after cutting and perforating. This film is used for motion-picture prints and sound recording.

* Method of indicating G is the main change from Z22.36–1947

† This dimension represents the length of any 100 consecutive perforation intervals.

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Appendix

(This Appendix is not a part of the foregoing Standard.)

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the film.

The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important.

PH22.36-1954

American Standard

Slides and Opaques for Television Film Camera Chains

ASA
Reg. U.S. Pat. Office
PH22.94-1954
Supplement to Z38.7.19-1950

*UDC 778.5

1. Scope

1.1 This standard is intended to supplement American Standard Dimensions for Lantern Slides, Z38.7.19–1950, not replace it. The television system imposes special requirements that did not enter into the preparation of Z38.7.19–1950.

1.2 The standard applies only to slides and opaques intended for transmission in the standard fashion via a film camera chain. For other applications, such as background projection, the usual television requirements may not apply.

2. Standard Dimensions

2.1 Nominal Size. Only the four nominal sizes listed in column 1 of the table shall be considered standard for use in television film camera chains.

2.2 Overall Dimensions. The overall dimensions for any nominal size shall comply with the dimensions tabulated in column 2. (See Note 1.)

2.3 Dimensions of Transmitted Picture. The portion of the slide or opaque intended for transmission shall lie within a centrally located rectangle having the dimensions shown in column 3. (See Note 2.)

2.4 Dimensions of Picture Background. The background (or the pictorial material) of the slide or opaque shall extend without interruption over a centrally located rectangle having the dimensions shown in column 4. (See Note 3.)

2.5 Centering Tolerance. The center of the transmitted picture rectangle and the center of the background rectangle shall both lie within a circle having as its center the center of the slide and as its radius the dimension tabulated in column 5.

Note 1. The overall dimensions are in accord with American Standard Dimensions for Lantern Slides, Z38.7.19–1950, insofar as it is relevant. The thickness of opaques is not covered by Z38.7.19–1950. This quantity is here specified as 1/32 inch on the assumption that opaques will consist of double-weight photographic paper without additional support or backing.

Note 2. The dimensions shown for the transmitted picture are those which will be scanned by a perfectly adjusted film camera chain. To allow for some misadjustment of the film camera chain and an additional misadjustment in the home receiver, it is recommended that all essential information be contained in a centrally located area appreciably smaller than that specified in column 3.

Note 3. In the case of slides, the background rectangle should be defined by an opaque mask to limit the stray light entering the film camera chain. The dimensions specified in column 4 permit the use of masks which comply with Z38.7.19–1950. For opaques, masking is generally provided by the projection equipment.

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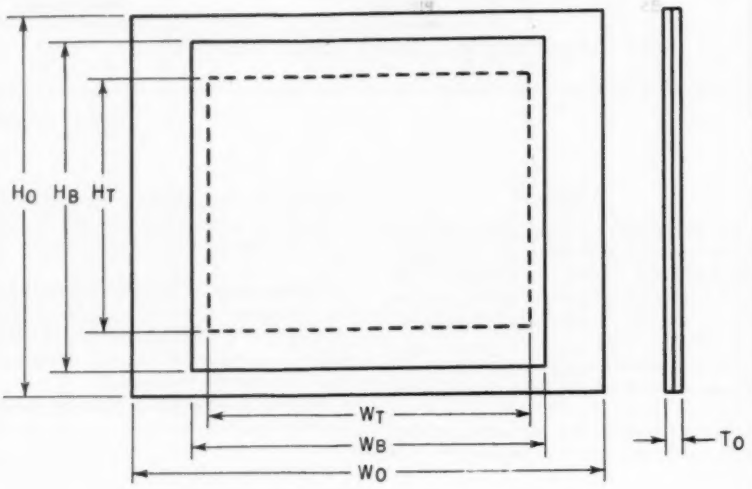


(1) Nominal	(2) Overall			(3) Transmitted Picture		(4) Picture Background		(5) Centering Tolerance
	H_O	W_O	T_O max.	H_T max.	W_T max.	H_B min.	W_B min.	
2 × 2 slide (double 35)	$2\ ^{+0}_{-1/32}$	$2\ ^{+0}_{-1/32}$	1/8	27/32	1 1/8	29/32	1 11/32	1/64
3¼ × 4 slide	$3\frac{1}{4}\ ^{+1/64}_{-1/32}$	$4\ ^{+1/64}_{-1/32}$	5/32	2 1/16	2¾	2¾	3	3/64
3¼ × 4 opaque	$3\frac{1}{4}\ ^{+1/64}_{-1/32}$	$4\ ^{+1/64}_{-1/32}$	1/32	2 1/16	2¾	2¾	3	3/64
4 × 5 opaque	$4 \pm 1/32$	$5 \pm 1/32$	1/32	3	4	3 3/16	4¼	1/16

All dimensions are in inches

PH22.94-1954

American Standard—Z57.1–1954

THE AMERICAN STANDARD, Method for Determining Flutter Content of Sound Recorders and Reproducers, Z57.1-1954, was approved by the American Standards Association on March 16, 1954, marking the conclusion of some eight years of effort.

This Standard was first proposed and the basic approach developed in 1946 by the Sound Committee of the Society under the chairmanship of John G. Frayne and was published for comment as a proposed standard in the August 1947 *Journal*. As a result of this publication, rather extensive comments were received from all fields of sound recording.

In October 1947 the American Standards Association set up a Sectional Committee on Sound Recording, Z57, sponsored jointly by the Institute of Radio Engineers and the Society. This proposed standard was referred for processing as its first American Standards project. In view of the comments that had been received, a subcommittee of Z57 under the chairmanship of Dr. E. W. Kellogg was appointed to attempt to resolve differences pointed up by these suggested modifications and to prepare another draft. This first Z57 draft, Z57/19, was circulated to the Z57 subcommittee and to the Sound Committee of the Society. The Sound Committee informed Dr. Kellogg's group that they desired further changes and in October 1948, a second draft, Z57/42, was circulated to all concerned.

Following circulation of this additional draft many months elapsed during which a consensus could not be reached on the matter of including weighted flutter and the flutter index. Also, some difference of opinion existed as to how to define such terms as flutter, flutter rate, flutter index, etc.

In January 1950 the third draft, Z57/58, which was thought to be acceptable, was duplicated and sent to the chairmen of the appropriate committees of the IRE, SMPTE, RMA and ASA. This limited circulation resulted in a few minor changes which were incorporated in still a fourth draft, Z57/63, which was sent to letter ballot of the Z57 Sectional Committee on August 10, 1950. It was still not possible to reach agreement, however, so this ballot was withdrawn. Further work on the proposed standard was undertaken by the Z57 subcommittee in an attempt to iron out the remaining differences regarding the definitions for flutter, flutter index, and weighted flutter. Agreement was finally reached on flutter and flutter index, and it was decided to omit all reference to weighted flutter in order to clear away the last obstacle.

This fifth draft, Z57.1/68, was approved by Sectional Committee Z57 on February 15, 1952, was subsequently approved by both sponsors of Z57, and has now become an American Standard.

It should be noted that the 1948–1952 SMPTE Sound Committee, under the chairmanship of Lloyd Goldsmith, played an important role in the development of this Standard; credit should also be given to William H. Deacy, Staff Engineer of the SMPTE for part of this period, for his considerable labor in shepherding this project through its manifold procedures and channels.

On July 15, 1953, the SMPTE withdrew its sponsorship of Sectional Committee Z57 leaving the IRE as sole sponsor. In its role as sponsor of Z57, the IRE has published this American Standard in the March 1954 issue of its *Proceedings*, page 537. Copies of the Standard can be purchased at 75¢ per copy directly from the IRE, 1 East 79 St., New York, N. Y.—*Henry Kogel*, Staff Engineer.

Section Meetings

The **Central Section** met on February 25, 1954, at the Western Society of Engineers. Malcolm G. Townsley, Assistant Vice-President and Director of Research, Bell & Howell Co., Chicago, presented a paper entitled "Photometry in Motion Pictures." As a well-qualified expert in this field, Mr. Townsley discussed the fundamental concepts of photometry and their application to motion picture production. He also included a discussion of the photometric properties of the special type of screens now being used for motion-picture projection.

A second paper was given by Carl F. Jensen, Regional Engineer for the Mid-American Region, Westinghouse Electric Corp., Lamp Div., Chicago, on "Some Projection Lamp Characteristics." From his broad experience in this particular field, Mr. Jensen presented an explanation in simple terms on the design of projection lamps and the optics involved. He also discussed reasons for short life of lamps and the factors that cause lamp problems in projection.

The March meeting of the Section was held on March 4 at Kimball Hall in Chicago. This was a joint meeting with the I.R.E. and the A.I.E.E., and the pre-meeting dinner was attended by 125 persons. A paper on "Color Television Receivers" was presented by William O. Swinyard, Chief Engineer of Hazeltine Research, Inc., who discussed in basic terms recent color television developments. He then described the NTSC television signals, the general nature of monochrome and color television set design, color resolution problems, and the solving of interference and transmission difficulties. The talk was well illustrated with excellent slides. Interest in the subject was so great that people had to be turned away at the door for lack of seating. It is estimated that some 400 people were present, including 100 members of the Section.—*K. M. Mason*, Secretary-Treasurer, Central Section, 137 N. Wabash Ave., Chicago.

The March meeting of the **Pacific Coast Section** was held at Paramount in Hollywood on the evening of March 23. Attendance was limited to members only, on a pre-reservation basis. Two sessions were held and both were filled to capacity, with a total attendance of 340 members. The subject was VistaVision, Paramount's new technique in motion-picture photography and projection.

C. R. Daily, Chief Optical Engineer at Paramount, described the process by which greater overall resolution is obtained in large-screen presentation. A wide-angle camera lens exposes an area 2½ times the normal size and at right angles to its normal position on the standard 35mm negative. The image is returned to its normal position for standard projection on the release film. A picture is composed for a normal 1.85:1 aspect ratio. Demonstrations from current color productions were shown at various aspect ratios on a new seamless curved screen 63 ft wide and 34 ft high.

Louis Mesenkop, Assistant Sound Director at Paramount, explained that a single photographic soundtrack will be provided with VistaVision. Three subaudio control signals will be superimposed on the track to permit presentation of dimensional sound in theaters equipped with suitable multiple channel and control facilities. This meeting was arranged through the courtesy of Loren Ryder, Director of Engineering and Recording for Paramount.—*E. W. Templin*, Secretary-Treasurer, Pacific Coast Section, c/o Westrex Corp., 6601 Romaine St., Hollywood 38.

The third meeting of the Board of Managers of the **Atlantic Coast Section** was held on March 24 at the Eastman Kodak Co. offices, 342 Madison Ave., New York City. On behalf of Everett Miller, the Chairman, George H. Gordon reviewed Mr. Miller's meeting with the Society's Board of Governors during the latter part of January. In particular, this involved consideration of the Atlantic Coast budget. It was announced that due to the reduced money available the program announcements used during the year 1953 had been changed to a postcard format. The members agreed to this change and further discussions were held concerning possible means of reducing current expenses.

It was agreed that the Section aim at an overall program of eight meetings for the calendar year 1954. This would provide

for regular monthly meetings except during the months of June, July, August and December. It was also announced that definite arrangements had been made for the April meeting in which the sound system of Robert Fine, PerspectaSound, will be presented. Tentative plans were also discussed for the May meeting. The Board also discussed a proposal to adopt a broad long range plan or theme for the future programs of the Section. It was pointed out that such a proposal would in itself help all the members of the Board to obtain suitable papers by directing our thinking and inquiries. A decision on this matter was deferred.

At a section meeting on Wednesday, March 24, Stanley Powers of the Densitometer Control Center, Color Technology Div., Eastman Kodak Co., presented a paper "A Chi Square Method for Controlling One or More Instruments or Processes." Mr. Powers pointed out that any industrial process had to be in control if it was to be profitable. Referring to the color densitometers used by the Eastman Kodak Co., Mr. Powers pointed out that inasmuch as these instruments were effectively the "yardstick" by which the materials or processes were measured, it was highly desirable that the various groups concerned have a uniform "yardstick." The development of the system of control which is applied to these instruments was explained in detail. The step-by-step procedure for establishing a control system was outlined. Following the paper there was an active discussion period. The application of these principles to one or more instruments was explored and the advantages to be gained by standardization were stressed.—*C. W. Seager*, Manager, Atlantic Coast Section, c/o Ansco, 405 Lexington Ave., New York 17.

Book Reviews

Drive-In Theatre (A Manual of Design and Operation)

By George M. Petersen. Published (1953) by Associated Publications, Kansas City, Mo. 226 pp. + 76 illus. Paper covered 6 × 9 in. Price $3.00

Mr. Petersen offers some timely advice on all phases of construction and operation for both prospective exhibitors and those who are now operating drive-in theaters. Among the many topics covered are site selection and design, financing, materials and construction, landscaping, lighting, drainage, sewage disposal, promotion, advertising, concessions, maintenance and insurance. In discussing each topic, the author is careful to present the methods and practices which he has found to be successful during his 14 years of experience with hundreds of drive-ins in the United States, Canada and Hawaii. The point emphasized early in the discussion is that, because the drive-in field is relatively new, advice by experts with considerable experience can help the new exhibitor to avoid initial costly mistakes.

Mr. Petersen's thesis is that success or failure is largely determined by the care given to the numerous details of the complicated business of building and operating a theater; and his coverage is consistent with this thesis. For example, in the chapter dealing with concessions, he goes to the extent of offering a special recipe for chili sauce. There are numerous diagrams, illustrative examples, and tables showing how to estimate floor space, costs, concessions and other facilities for a given number of cars. Of special interest to operators of existing establishments are the chapters describing profitable promotional schemes, and the techniques of handling concessions of many kinds including the increasingly popular "kiddylands." Considerable space is devoted to what might be classed as "pep talks" for the operating personnel.

The entire book is written in a straightforward, factual style, convincing in its thoroughness, and directed toward expounding those factors which constitute honest showmanship and form the basis of a sound business enterprise. The broad principles of pleasing the patron, as presented by the author, are not limited to the drive-in theater.

Some of the content of the book has appeared previously in the *Modern Theatre* section of *Boxoffice*. The book as a whole is well unified, and is not a mere collection of separate articles.—*Rowland H. Müller*, General Precision Laboratory Inc., Pleasantville, N. Y.

Sound Film Projection, Fourth Edition

Edited by E. Molloy; Contributors, F. W. Campbell, T. A. Law, L. F. Morris and A. T. Sinclair. Published (1951) by George Newnes, Ltd., Tower House, Southampton St., London, W.C.2. i–vii + 330 pp. + 8 pp. index. 228 illus. 6 × 9 in. Price 30 shillings ($4.20) net.

For readers in this country, the chief value of the book is as a reference source of general background interest. Material on installation, maintenance, trouble shooting ("fault tracing") and repair is presented with a touch that reveals much practical experience, and sympathy with the plight of the novice who has to be shown exactly how something is done. Since all the projectors, and most of the soundheads and amplifiers are of English origin, little of this operating information is directly usable, other than as a basis for comparison against our own practices. For example, one gathers that some of the service operations with which a British projectionist must be familiar are not the normal duties of a projectionist in this country; and this difference may be of interest. Technical descriptions of design features not commonly encountered here are clearly presented and well illustrated.

Systems of sound-film projection dealt with in detail are: R.C.A. Photophone, Gaumont-Kalee and British Acoustic, British Thomson-Houston, and Western Electric. Sound-reinforcement equipment and public-address systems are reviewed. There is a chapter on theater television, but the information is necessarily earlier than the publication date of the book.—*Willy Borberg*, General Precision Laboratory Inc., Pleasantville, N. Y.

Theatre Catalog, 11th Annual Edition, 1953-1954

Published (1953) by Jay Emanuel Publications, Inc., 246–48 N. Clarion St., Philadelphia 7. i–xxxii + 379 pp. Profusely illus., includes advtg. 9¼ × 12¼ in. Price $5.00 (foreign shipments $10.00 a copy).

Theatre Catalog is an impressive yearbook on theater construction, design, maintenance, operation and advertising. Everything from acoustics to television is covered in this year's issue. Comprising a collection of articles by leaders in their respective fields, the catalog is divided into three books: (1) Design and Construction, (2) Equipment, and (3) Management. The first book covers design, construction and drive-in theaters, and is profusely illustrated with almost 200 photos. A complete listing of all operating drive-ins in the U.S. is also included. The second book contains articles on signs and marquees, snow-melting sidewalks, new projection and sound-equipment techniques for 3-D, wide-screen, stereosound, etc., and installation and maintenance information on seating, flooring, and carpeting. Of particular interest is an article by SMPTE President Herbert Barnett describing and evaluating the various new projection and sound systems recently developed for the industry. The third book contains articles on promotion and management, parking problems, advertising and theater television. An editorial feature describes and illustrates the work of theater architect Ben Schlanger. There is a complete subject index to the present issue of the catalog as well as a cumulative index to all previous editions.—*Rowland H. Müller*, General Precision Laboratory, Inc., Pleasantville, N. Y.

Farbenmetrik

By Dr. Hans Arens. Published (1951) by Akademie-Verlag GmbH., Berlin NW7, Schiffbauerdamm 19. 68 pp. + 8 pp. glossary + 3 pp. index. 38 illus. 6¾ × 9¾ in. $3.31.

This book is a short survey of color with special reference to color measurement. The purpose of the book, and of others in a projected series of small books, is to supply a need for technical background information among those concerned with the numerous applications of color photography.

Most of *Farbenmetrik* divides into two parts, the first of which is concerned with the characteristics of color. Color is considered both from the perceptual point of view and the physical or stimulus standpoint. The perceptual development is strictly according to Hering and Ostwald. The four primary colors, red, yellow, green and blue (Urfarben), together with black

and white in appropriate mixtures yield all colors. The mixture with black and white corresponds to the achromatic component in most perceived colors. These colors of varying lightness and saturation are known as white-, black- and gray-veiled ("verhüllt") colors. The discussion of color from the stimulus standpoint purports to deal with the physical correlates of this color-veiling.

The second part of the book treats more directly of color measurement; but as before the topic is broken down into stimulus and response aspects. Following an introduction to such familiar fundamentals as spectrophotometric curves, Grassmann's laws, vectorial representations and transformations of systems, there is a detailed treatment of the Luther color moment and solid. This ties in with Ostwald and according to the author affords the best approach to color measurement congruent with perceived color. Evaluations of color-veiling, color thresholds and color differences are briefly considered; and finally some of the methods of establishing functional relations between perceptual and psychophysical color systems are mentioned.

Granted that a satisfactory survey of color in the compass of 76 pages is a formidable task, the results are disappointing. The sources of material consulted were apparently very limited; Judd and Munsell are scarcely mentioned despite the author's evident interest in color appearance. Little or no account is taken of numerous investigations and topics of obvious relevance. Furthermore and contrary to reasonable expectation, the subject matter of color has not been especially related to color photography. There are also terminological difficulties such as the continued use of the term "Helligkeit" to indicate either brightness or luminance. Such shortcomings should not be blamed on the author; for the book happened to appear just as many changes in the German nomenclature were being put into effect. It is apparent, however, that this publication cannot be strongly recommended to the uninformed reader to whom it is largely addressed.

On the other hand, there are a number of favorable features. Among these may be mentioned excellent examples in the introduction illustrating color principles, an effort toward a stimulus-response organization of the subject matter, a critical statement of the principle of additivity of luminance, a discussion of Luther's moment which may interest the expert, and a technical glossary of 90 items. The desirability or undesirability of the author's general position may be left up to the reader. This is that visual colorimetrics are more valuable and important for color photography than is conventional colorimetry.

Günter Wyszecki contributed substantially to this review by reading the book and making his comments freely available.—*Sidney M. Newhall*, Eastman Kodak Co., Rochester 4, N.Y.

French Film

By Georges Sadoul. Published (1953) by the Falcon Press (London) Ltd. Distributed in the U.S. by The British Book Centre, Inc., 122 E. 55 St., New York 22. 131 pp. Illus. Subject Index. $7\frac{1}{2} \times 10$ in. $3.50.

The considerable public in this country that frequents French films will be extremely interested in this little book. Beginning with the early contributions of France to the development of motion-picture equipment, and the professional controversies between Lumière and Melies, the author follows the ups and downs of French film production over the years.

Beset by financial troubles and difficulties in obtaining equipment tied up by foreign patents, the French motion-picture industry, like that of Europe generally, has had to depend on a minimum of material and a maximum outlay of ingenuity. Following Rene Clair's successful invasion of world markets in the early 30's a handful of brilliant directors have given the French film an enviable reputation for artistic and technical merit. Their work is briefly but comprehensively reviewed in these pages, accompanied by a good selection of stills; and the consequent listing of pictures, with brief descriptions, makes an excellent guide to the major French productions.—*D.C.*

Motion-Picture Catalogs

Motion pictures, from the *Edison Kinetoscope Record of the Sneeze*, more frequently referred to as *Fred Ott's Sneeze*, produced in 1894, to such films as *She Wore a Yellow Ribbon*, produced in 1949, are listed in three catalogs issued by the Library of Congress. Two of the volumes—*Motion Pictures*,

1894–1912 and *Motion Pictures, 1940–1949*—have just been published and they, together with *Motion Pictures, 1912–1939*, issued in 1951, provide an unbroken, 55-year record of the copyright registration of more than 76,000 motion pictures in this country. Foreign films registered for United States copyright are also listed.

The content of the various entries differs slightly because of changes in the copyright laws, requirements and procedures over the years, but the entry for each film usually includes the title, date, producing company, facts about the published work on which the film was based, and the author of the film story. Orders should be sent to the Copyright Office, Library of Congress, Washington 25, D.C. Costs are $2.00 for the 92 pp. covering 1894–1912, $18.00 for the 1250 pp. of the 1912–1939 span, and $10.00 for 598 pp. on 1939–1949.

Current Literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N. Y., at prevailing rates.

American Cinematographer

vol. 35, Jan. 1954

Projection Viewing With the Westrex Editer (p. 23) *L. Allen*

The Zoomar Varifocal Lens for 16mm Cameras (p. 27) *A. D. Roe*

vol. 35, Feb. 1954

New Arriflex Cameras Feature Many Improvements (p. 80) *A. Rowan*

Care and Handling of Film in the Tropics (p. 89) *J. Forbes*

British Kinematography

vol. 23, no. 6, Dec. 1953

Studio Spotlights. Summary of Tests (p. 156)

Factors Affecting 16mm Picture Illumination and Quality (p. 160) *D. S. Morfey*

Canadian Film News

October 1953

Pixilation by *Norman McLaren* (Reprinted in Rushes for Dec. 7, 1953, Film Council of America)

Proceedings of the I.R.E.

vol. 42, Jan. 1954

A Versatile Approach to the Measurement of Amplitude Distortion in Color Television (p. 240) *J. A. Bauer*

Test Instruments for Color Television (p. 247) *W. C. Morrison, K. Karstad and W. L. Behrend*

Delay Equalization in Color Television (p. 258) *G. L. Fredendall*

Alignment of a Monochrome TV Transmitter for Broadcasting NTSC Color Signals (p. 263) *J. F. Fisher*

Transmission of Color Over Inter-City Television Networks (p. 270) *J. R. Rae*

Improving the Transient Response of Television Receivers (p. 274) *J. Avins, B. Harris and J. S. Horvath*

Theory of Synchronous Demodulator as Used in NTSC Color Television Receiver (p. 284) *D. C. Livingston*

The DC Quadricorrelator: A Two-Mode Synchronization System (p. 288) *D. Richman*

Processing of the NTSC Color Signal for One-Gun Sequential Color Displays (p. 299) *B. D. Loughlin*

Compatible Color Picture Presentation With the Single Gun Tricolor Chromatron (p. 308) *J. D. Gow and R. Dorr*

Improvements in the RCA Three-Beam Shadow-Mask Color Kinescope (p. 315) *M. J. Grimes, A. C. Grimm and J. F. Wilhelm*

The CBS Colortron: A Color Picture Tube of Advanced Design (p. 326) *N. F. Fyler, W. E. Rowe and C. W. Cain*

A Laboratory Receiver for Study of the NTSC Color Television System (p. 334) *C. Masucci, J. J. Insalaco and R. Zitta*

Bibliography of Color Television Papers Published by the IRE (p. 350)

International Photographer

vol. 26, Jan. 1954

Recording TV Pictures on Magnetic Tape (p. 5)

vol. 26, Feb. 1954

Color Television (p. 5)

International Projectionist

vol. 29, Jan. 1954

1954 Seen as Biggest Year for Color (p. 7) *J. Morris*

Recent Projection Advances in Europe (p. 9) *R. A. Mitchell*

Color is Catalyst in Battle of the Tubes (p. 14) *F. Hodgson*

The 3-D Score for '54 (p. 16) *T. L. Burnside*

vol. 29, Feb. 1954

That Hardy Perennial: Damaged Film! (p. 9) *J. Morris*

Proper Tools a 3-D 'Must'. (p. 12) *S. Cohen*

Atom-Smasher Principle Aids Color TV (p. 14) *F. Hodgson*

Light Gain, Better Screens Demanded by New Systems (p. 17) *L. Satz*

Kino-Technik

vol. 8, Jan. 1954

Bedeutung und Ausführung des Tricks (p. 2) *H. Burdich*

Tier- und Pflanzenfilme auf Ferrania-Color-Material (p. 7) *G. Beissert*

Messkinematographische Aufnahmen mit dem Kurvenauswertgerät: "Messkineautograph" (p. 8)

Störungen bei der Vorführung von Tonfilmen (p. 12) *H. Tummel*

Rundgang durch die italienischen Ateliers (p. 14) *E. Monachesi*

vol. 8, Mar. 1954

Photo-, und Film-Aufnahmeverfahren vom Luftfahrzeug aus. (p. 58) *H. Atorf*

Kino-Farbfilmaufnahmen in grösseren Meerestiefen (p. 62) *D. Rebikoff*

CinemaScope-Wände—Grössenbestimmung und Aufstellung (p. 66) *W. Struve*

Anamorphotische Optik—die Grundlage für CinemaScope (p. 69) *H. Kohler*

Motion Picture Herald (Better Theatres Sec.)

vol. 194, Feb. 6, 1954

Drive-In Designed for "Daylight" Projection (p. 48)

A Dictionary of Maintenance (p. 61) *C. Mees*

vol. 194, Mar. 6, 1954

Projection Room Procedure With CinemaScope Type Film (p. 31) *G. Gagliardi*

PSA Journal

vol. 20, Mar. 1954

Motion Pictures With Magnetic Sound (p. 24) *M. Camras*

Radio & Television News

vol. 51, Mar. 1954

The Chromatic Color Picture Tube (p. 52) *W. H. Buchsbaum*

vol. 51, Apr. 1954

Fundamentals of Color TV. The NTSC System (p. 59) *M. S. Kiver*

Revue du Son

no. 4–5, July–Aug. 1953

Les microphones: principes et caractéristiques des divers types (p. 147) *R. Lehmann*

Le controle électro-acoustique au cinéma. Essais sur films (p. 171) *C. Soulé*

no. 6, Sept. 1953

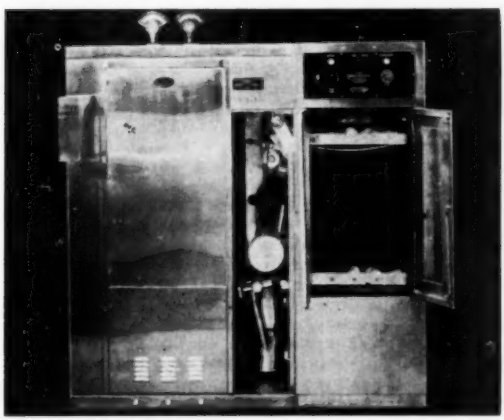
Les microphones: principes et caractéristiques des divers types (p. 193) *R. Lehmann*

La production des films en stéréophonie (p. 207) *L. Martin*

Un second amplificateur "son" pour la télévision (p. 217) *L. Chrétien*

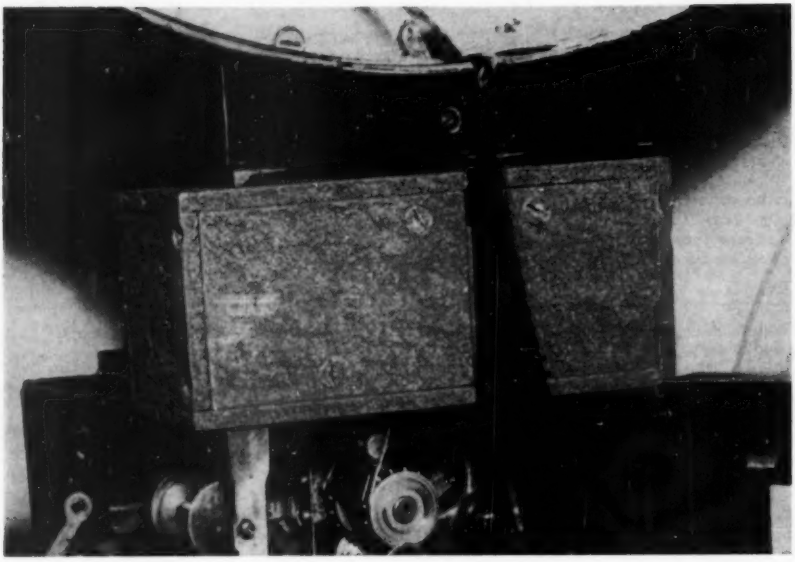
New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.



A new multipurpose film processor for 16mm, 35mm or 70mm film is announced by the Oscar Fisher Co., Peekskill, N.Y. The processor is designed for daylight operation and will process films of any length, perforated or unperforated.

Specifications are: dimensions 7 ft × 24½ in. × 7 ft high; processing speed adjustable from 1 fpm to 50 fpm; jet spray system; recirculation of 5 gal per chemical bath with automatic replenishment; stainless steel cabinet; adjustable thermostatic temperature controls to 120°; Fisher Anhydrator system of heatless drying; 290 ft of film or leader required for machine capacity; operates on standard 110-v, 60-cycle line, 1500-w maximum load. By addition of extra "wet" cabinets either reversal or color films can be processed.



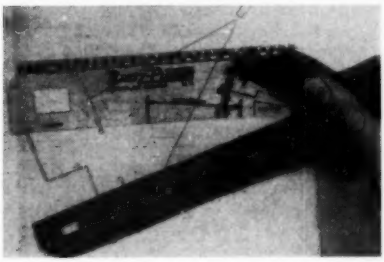
Panaphonic sound is a new low-cost stereophonic sound system developed by Dorsett Laboratories, Inc., Norman, Okla. The equipment operates on a binary signal system from darkened intersprocket spaces at both edges of the film, sensed by two small photocells whose amplified outputs operate relay tubes to provide four loudspeaker combinations — center, right or left horns, and all speakers including side and rear of the auditorium. The system is designed to be compatible with present sound systems and does not affect picture projection.

The cue lead is adjusted by the timing circuit to conform to all types of projectors which are currently used. An integrating circuit together with the filter also serves to eliminate spurious cues due to film splices or other causes. In order to permit addition of cue marks to prints already in release, a special automatic cuing machine has been developed which applies a dye to the intersprocket spaces, dries it and rewinds the takeup reel. In the case of new prints, the cue marks can, of course, be darkened photographically.

A new drive-in theater stereophonic sound system has been demonstrated by Dorsett Laboratories, Inc., Norman, Okla., avoiding the use of multiple audio circuits and a plurality of audio amplifiers. The signals from the soundtracks are picked up and amplified in the usual single high-powered audio amplifier used in all drive-in theaters. In addition, certain control signals are picked up from the film or otherwise introduced. The loudspeaker to go in the automobile consists of three small dynamic loudspeakers installed in a single enclosure and alternately or simultaneously connected to the output of the single audio amplifier through a suitable relay controlled by the directive effect control signals. By this means signals from the soundtrack can be directed to the center speaker for dialog, to the left speaker for left screen sounds, to the right speaker for right screen sounds, or to all speakers simultaneously for surround effects. The new speakers may also be used with three-circuit stereophonic systems by adding another pair of wires. These may be combined with the existing audio pair to provide three audio circuits; four wires with one a common return. In this case, three separate channels and amplifiers are used, as in regular stereophonic sound.

The Schall-Technik Condenser Microphone CM 51, with power supply, is distributed here by Reeves Equipment Corp., 10 E. 52 St., New York 22. Frequency response is claimed to be uniform throughout the range of 30–18,000 cycles, and transient oscillations to be absent. Its construction is designed to make it insensitive to moisture, temperature and mechanical accelerations. Two pickup patterns are available, cardioid and nondirectional. The head capsules for each pattern are plug-in and can be purchased separately. The high output of this system permits operation at considerable dis-

tances from the mixer without impairing the frequency response and with freedom from inductive pickup in the cables.



The Bretz-Plotter, described as "the TV director's slide rule," is a new shot-plotter for laying out a new set or new camera placements. It can be used to measure angles, distance from camera, height of scene, or size of sets or props, and to indicate horizontal angle of view of all TV lenses, range of principal Zoom lenses, maximum and minimum extensions of mike boom, and vertical angles of view of standard lenses. The plotter is designed to help in determining the lens required for a given shot, the camera position required, the shot resulting from given camera position and lens, the position of mike boom base, and the height of shot at any distance from the camera. The price is $3.00, or $2.50 apiece for quantities of 10 or more, available from Rudy Bretz, Television Consultant, Park Trail, Croton-on-Hudson, N.Y.

Employment Service

These notices are published for the service of the membership and the field. They are inserted for three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion-Picture Television Technician: 10 yr intensive skill and know-how related to 16-35mm cinematography, animation, recording (optical, tape, disk), editing, laboratory processing practice (black-and-white, color); also kinescope recording techniques; self-reliant; inventive; relocate if required; write: CMC, c/o Penning, 435 E. 74th St., New York 21, N.Y.

Electronics Engineer: B.S.E.E., 3 yrs chemical engineering, 2 yrs graduate work in physics. Currently working on Masters Degree. Engaged in gaseous electronics research, experienced in design and development of electronic instrumentation, installation and operation of automatic recording temperature control systems, vacuum system technique, maintenance and repair of all types of electronic equipment. 4 yrs retail business experience. Possess ability to write clear, concise reports. Interested in the motion picture, both artistically and technically. Desire position with organization in Los Angeles area preferably engaged in motion-picture production. Expect to be in Los Angeles area in late summer this year. Request interview. Member, IRE, SMPTE, Fla. & Nat. Soc. of Prof. Engs. Registered Engineer in Training State of Florida. Age, 28; unmarried. Write: Berel David Solomon, Box 274, Univ. Station, Miami, Fla.

Motion-Picture Producer-Director: Now employed in charge of motion-picture production for leading oil company. 18 yrs experience in production, script, direction, motion-picture photography, editing, scoring and recording of industrial, sales training, educational, travel and theatrical motion pictures. Highly experienced in low budget productions for industry. Available in near future; employer has been notified of desire for change to better position. Address inquiries to: A. P. Tyler, Box 2180, Houston, Tex.

Motion-Picture Cameraman: Wants position assisting editor or with production crew. College graduate, film production major, production experience prior to entering Service. Army cameraman for 2 yr in Arctic. Separation from Army July 16, 1954. Will consider temporary position and/or travel. Write Elliott H. Butler, 470 Audubon Ave., New York 33.

Motion-Picture Cameraman, Film Editor: 15 yrs experience all phases of motion-picture work, including research; 3 yrs TV film operations. Developer of Panoramascope wide-screen motion-picture system. Active Member of SMPTE. Desires position with industrial or educational film producer as first cameraman or film editor. Wire: Frank E. Sherry, Jr., 207 West Rusk St., Tyler, Tex.

Positions Available

Motion-Picture Sound Mixer (male), GS-10: Require 5½ yr experience in sound mixing for radio, disk recording and motion-picture production, of which at least 3 yr must have been in mixing for motion-picture production, include experience with live dialogue, narration, music, sound effects, lip synchronization and re-recordings. $5500/yr. Obtain Form SF 57 at any first class Post Office or Government Agency; forward or deliver completed to Civilian Personnel Div., Signal Corps Pictorial Center, 35-11 35 Ave., Long Island City, N.Y.

Motion-Picture Asst. Director (male), GS-10: Require 5½ yr progressively responsible experience in motion pictures, theatrical, television broadcast or radio broadcast production which has demonstrated the ability to perform in this position. Included in general experience must be at least 2½ yr experience as a first assistant director in motion-picture production. $5500/yr. Obtain Form SF 57 at any first class Post Office or Government Agency; forward or deliver completed to Civilian Personnel Div., Signal Corps Pictorial Center, 35-11 35 Ave., Long Island City, N.Y.

Chicago Film Studio needs man to take charge stop-motion and animation dept. Must be experienced, able to direct title and animation cameramen. Write giving experience and salary desired. Filmack Corp., 1327 S. Wabash Ave., Chicago 5, Ill.

Meetings

Society of Photographic Engineers, Fourth Annual Conference, May 26–28, U.S. Hotel Thayer, U.S. Military Academy, West Point, N.Y. Some 35 titles have been scheduled. For information write: Anthony E. Salerno, c/o Pavelle Color, Inc., 533 W. 57 St., New York 19.

Society of Motion Picture and Television Engineers, Central Section (with Western Society of Engineers), June 10

American Institute of Electrical Engineers, Summer General Meeting, June 21–25, Los Angeles, Calif.

Acoustical Society of America, June 22–26, Hotel Statler, New York

American Physical Society, June 28–30, University of Minnesota, Minneapolis, Minn.

American Physical Society, July 7–10, University of Washington, Seattle, Wash.

National Audio-Visual Convention and Trade Show, Aug. 1–4, Conrad Hilton Hotel, Chicago.

Biological Photographic Association, Annual Meeting, Aug. 25–27, Chalfonte-Haddon Hall, Atlantic City.

Illuminating Engineering Society, National Technical Conference, Sept. 12–16, Chalfonte-Haddon Hall, Atlantic City, N.J.

2d International Symposium on High-Speed Photography, Paris, September 22–28, 1954. Arranged by the Association Française des Ingénieurs et Techniciens du Cinéma. Applications or inquiries should be addressed to the Secretary of the Organizing Committee, P. Naslin, Laboratoire Central de l'Armement, Fort de Montrouge, Arceuil (Seine), France.

National Electronics Conference, Tenth Annual Conference, Oct. 4–6, Hotel Sherman, Chicago.

Photographic Society of America, Annual Meeting, Oct. 5–9, Drake Hotel, Chicago, Ill.

American Institute of Electrical Engineers, Fall General Meeting, Oct. 11–15, Chicago, Ill.

76th Semiannual Convention of the SMPTE, Oct. 18–22, Ambassador Hotel, Los Angeles

77th Semiannual Convention of the SMPTE, Apr. 17–22, 1955 (next year), Drake Hotel, Chicago

The International Commission on Illumination is to hold its next international conference in Zürich, Switzerland, June 13–22, 1955 (*next year*). Offers of papers should be addressed to the Chairman of the Papers Committee (A. A. Brainerd), 1015 Chestnut St., Philadelphia 7. Manuscripts must be in the hands of the Central Bureau between Oct. 1 and Dec. 31, 1954.

78th Semiannual Convention of the SMPTE, Oct. 3–7, 1955 (next year), Lake Placid Club, Essex County, N.Y.

Photographic Society of America, 1955 Convention, Oct. 5–8, 1955, Sheraton-Plaza Hotel, Boston, Mass.

Society of Motion Picture and Television Engineers

40 West 40th Street, New York 18, N. Y., Tel. LOngacre 5-0172
Boyce Nemec, Executive Secretary

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